HUEY, GUILDAY & TUCKER, P. A.
ATTORNEYS AT LAW
106 EAST COLLEGE AVENUE
SUITE 900, HIGHPOINT CENTER
TALLAHASSEE, FLORIDA 32301

POST OFFICE BOX 1794
TALLAHASSEE, FLORIDA 32302
www.hueylaw.com
TEL: (850) 224-7091
FAX: (850) 222-2593
e-mail: andy@hueylaw.com

ROBERT D. FINGAR
THOMAS J. GUILDAY
J. MICHAEL HUEY††
GEOFFREY B. SCHWARTZ††
VIKKI R. SHIRLEY
M. KAY SIMPSON
J. KENDRICK TUCKER*
MICHAEL D. WEST
WILLIAM E. WILLIAMS††

JOHN S. DERR
ROBIN C. NYSTROM
CLAUDE R. WALKER**†
OF COUNSEL

J. ANDREW BERTRON, JR.
GEORGE W. HATCH, III
ROBERTO M. VARGAS

JOHN ANDREW SMITH
CHRISTOPHER K. HANSEN
GOVERNMENTAL CONSULTANTS

*ADMITTED IN FLORIDA & DC
†BOARD CERTIFIED REAL ESTATE LAWYER
††CERTIFIED CIRCUIT CIVIL MEDIATOR
**CERTIFIED PUBLIC ACCOUNTANT, FL

ORIGINAL

September 27, 1999

BY HAND DELIVERY THIS DATE

Blanca S. Bayo
Director, Division of Records and Recording
Florida Public Service Commission
2540 Shumard Oak Blvd.
Tallahassee, Florida 32399-0850

Re: Docket #990750-TP; Petition for Arbitration by ITC^DeltaCom Communications

Dear Ms. Bayo:

On behalf of ITC^DeltaCom Communications, Inc., enclosed for filing in the referenced docket are an original and 16 copies of ITC^DeltaCom's:

1. Answers and Objections to BellSouth's First Set of Interrogatories
2. Responses to BellSouth's First Request for Production of Documents
3. Answers and Objections to Staff's First Set of Interrogatories
4. Responses to Staff's First Request for Production of Documents

Please file stamp the extra enclosed copy of each document and return them to our runner. Thank you for your assistance.

Sincerely,

HUEY, GUILDAY & TUCKER, P.A.

J. Andrew Bertron, Jr.

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(2) DOCUMENT NUMBER-DATE 11649 SEP 27 99 FPSC-RECORDS/REPORTING

(3) DOCUMENT NUMBER-DATE 11650 SEP 27 99 FPSC-RECORDS/REPORTING

(4) DOCUMENT NUMBER-DATE 11651 SEP 27 99 FPSC-RECORDS/REPORTING

BEFORE THE

FLORIDA PUBLIC SERVICE COMMISSION

ORIGINAL

In Re:	)	
	)	
Petition for Arbitration of	)	**Docket No. 990750-TP**
ITC^DeltaCom Communications, Inc.	)	
With BellSouth Telecommunications, Inc.	)	
Pursuant to the Telecommunications	)	
Act of 1996	)	
	)	

ITC^DELTACOM COMMUNICATIONS, INC.'S RESPONSES AND OBJECTIONS TO BELLSOUTH TELECOMMUNICATIONS, INC.'S FIRST SET OF INTERROGATORIES

Petitioner, ITC^DeltaCom Communications, Inc. ("ITC^DeltaCom"), provides its answers and objections to BellSouth Telecommunications, Inc.'s First Set of Interrogatories as follows:

Interrogatory No. 1: Identify all persons participating in the preparation of the answers to these Interrogatories or supplying information used in connection therewith.

Response: Don Wood, Thomas Hyde, Michael Thomas, and Christopher J. Rozycki.

Interrogatory No. 2: Identify each person whom you expect to call as an expert witness at the arbitration hearing. With respect to each such expert, please state the subject matter on which the expert is expected to testify, the substance of the facts and opinions to which the expert is expected to testify, and a summary of the grounds for each opinion.

Response: The experts whom we expect to call are those who pre-filed testimony

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in this case. The subject matter covered by those experts is summarized in the initial section of their respective pre-filed testimony.

Interrogatory No. 3: Identify each person whom you have consulted as an expert in anticipation of this arbitration or in preparation for a hearing in this arbitration who is not expected to be called as a witness. With respect to each such expert, please state the facts known by and opinions held by this expert concerning any matters raised in the Arbitration Petition.

Response: ITC^DeltaCom objects to this Interrogatory because it is not reasonably calculated to lead to admissible evidence.

Interrogatory No. 4: Identify all documents which refer or relate to any issues raised in the Arbitration Petition that were provided or made available to any expert identified in Response to Interrogatory Nos. 2 or 3.

Response: ITC^DeltaCom objects to this question to the extent it calls for attorney-client privileged information. All documents referred to by the experts identical in response to Interrogatory Numbers 2 and 3 are publicly available and have been filed with a state regulatory commission in a proceeding to which BellSouth has been a party. Thus, these documents are in the possession of BellSouth.

Interrogatory No. 5: State the recurring and nonrecurring rates you contend BellSouth should charge ITC^DeltaCom for an unbundled 2-wire ADSL/HDSL compatible loop in Florida. In answering this Interrogatory, please describe with particularity the method by which these rates were calculated.

Response: BellSouth must produce a cost study in compliance with the FCC's pricing methodology. Subject to true-up, the interim rates should be based on the voice grade recurring and non-recurring rates from ITC^DeltaCom's existing interconnection agreement which was previously approved by this commission. Those rates should then be reduced by 25% to reflect the cost savings associated with the removal of subscriber loop carrier equipment cost from the cost study as it cannot be used with ADSL/HDSL. Further, BellSouth should refer to the Rebuttal Testimony of Thomas Hyde addressing appropriate non-recurring costs for UNE loops. The Rebuttal Testimony of Don Wood sets forth the establishment of interim recurring rates for ADSL/HDSL compatible loops.

Interrogatory No. 6: State the recurring and nonrecurring rates you contend BellSouth should charge ITC^DeltaCom for an unbundled 4-wire HDSL compatible loop in Florida. In answering this Interrogatory, please describe with particularity the method by which these rates were calculated.

Response: See Response to Interrogatory Number 5, above.

Interrogatory No. 7: State the recurring and nonrecurring rates you contend BellSouth should charge ITC^DeltaCom for an unbundled 2-wire SL1, 2-wire SL2, 2-wire SL2 Order Coordination for Specified Conversion Time, Extended Loops and Loop-Port Combination Services. In answering this Interrogatory, please describe with particularity the method by which each of these rates was calculated.

Response: BellSouth must produce a cost study in compliance with the FCC's pricing methodology. Subject to true-up, the interim rates should be the nonrecurring and recurring rates contained in ITC^DeltaCom's interconnection agreement filed and approved with this Commission. BellSouth should also refer to Mr. Hyde's Rebuttal Exhibit relating to the appropriate non-recurring costs for 2-wire SL1 and SL2 grade loops. BellSouth should also refer to the Rebuttal Testimony of Don Wood.

Interrogatory No. 8: Identify all studies, evaluations, reports, or analyses prepared by or for ITC^DeltaCom since January 1, 1996 that refer or relate to the cost to BellSouth or any other Incumbent Local Exchange Carrier of providing any of the unbundled network elements or other services requested by ITC^DeltaCom in its Arbitration Petition.

Response: Now that the FCC Rules have been reinstated, BellSouth must produce a cost study that is compliant with the FCC pricing methodology. That study should form the basis of the Commission's determination of BellSouth's costs. ITC^DeltaCom has not completed a cost study that accurately reflects the FCC pricing rules.

Interrogatory No. 9: Please explain in detail what activities you contend are required for BellSouth to provide ITC^DeltaCom with an unbundled loop to serve an existing BellSouth customer who has elected to switch its local service to ITC^DeltaCom. In answering this Interrogatory, please describe with particularity:

(a) the basis for your explanation, including identifying any studies, evaluations, reports or analyses upon which your explanation is based; and

(b) any differences in these activities depending upon the type of unbundled loop that is being provided.

Response: These activities should be covered by BellSouth's cost study. ITC^DeltaCom received a copy of BellSouth's study and has not fully evaluated its contents.

Interrogatory No. 10: Please explain in detail what activities you contend are required for BellSouth to provide ITC^DeltaCom with an unbundled loop to established service for a new customer who has chosen ITC^DeltaCom as its provider of local service. In answering this Interrogatory, please describe with particularity:

(a) the basis for your explanation, including identifying any studies, evaluations, reports, or analyses upon which your explanation is based; and

(b) any differences in these activities depending upon the type of unbundled loop that is being provided.

Response: See Response to Interrogatory Number 9, above.

Interrogatory No. 11: Are there any types of unbundled loops that you have requested from BellSouth that you contend BellSouth has refused to provide on an unbundled basis? If the answer is in the affirmative, please:

(a) identify with particularity the type of unbundled loop you requested which BellSouth allegedly has refused to provide;

(b) state the date when you first requested the unbundled loop and the date BellSouth allegedly refused to provide it;

(c) state the reasons purportedly given by BellSouth for its refusal to provide such unbundled loop; and

(d) identify all documents that refer or relate to ITC^DeltaCom's request for or BellSouth's refusal to provide each such unbundled loop.

Response: No.

Interrogatory No. 12: Identify all states in which ITC^DeltaCom has requested an Incumbent Local Exchange Carrier (other than BellSouth) to provide ITC^DeltaCom with an "extended loop and loop/port combination." In answering this Interrogatory, please:

(a) identify the Incumbent Local Exchange Carrier to whom the request was made;

(b) state the date of ITC^DeltaCom's request and the date of the Incumbent Local Exchange Carrier's response; and

(c) describe with particularity the Incumbent Local Exchange Carrier's response to ITC^DeltaCom's request.

Response: ITC^DeltaCom filed with the Texas PUC, a negotiated interconnection agreement with Southwest Bell Communications ("SBC") that includes extended loops. The agreement was filed on July 21, 1999 and approved on August 25, 1999. ITC^DeltaCom submits that the Commission should consider the extended loop provisions of that agreement for guidance in this case.

Interrogatory No. 13: Identify all states in which ITC^DeltaCom is providing local exchange service and identify the number of access lines being served by ITC^DeltaCom in each such state.

Response: ITC^DeltaCom objects to this question on the grounds that it is not reasonably calculated to lead to the discovery of admissible evidence. Moreover, BellSouth is a direct competitor of ITC^DeltaCom and this information is proprietary. With regard to the BellSouth territories, BellSouth has this information in its possession.

Interrogatory No. 14: Identify the location of each physical collocation space leased by ITC^DeltaCom or applied for by ITC^DeltaCom from any Incumbent Local Exchange Carrier, including BellSouth. In answering this Interrogatory, please:

(a) Identify the Incumbent Local Exchange Carrier from which ITC^DeltaCom is leasing such physical collocation space;

(b) state with particularity all costs incurred by ITC^DeltaCom in connection with leasing each such physical collocation space, including identifying all recurring and nonrecurring costs charged by the incumbent for ITC^DeltaCom's use of that space; and

(c) state the interval in which each such physical collocation space was provided, including identifying all dates used to determine this interval (i.e., the date of ITC^DeltaCom's request for the collocation space and the date the space was made available.

Response: BellSouth controls the information in (a), (b) and (c) as it relates to BellSouth. With regard to other ILECs, such information is proprietary and confidential.

Interrogatory No. 15: State the recurring and nonrecurring rates you contend BellSouth should charge for cageless/shared collocation in Florida including cross-connects. In answering this Interrogatory, please describe with particularity the method by which these rates were calculated, including identifying any cost studies, analyses, or other inquiries conducted to derive the rates.

Response: Please refer to the pre-filed testimony of ITC^DeltaCom witness Don Wood.

Interrogatory No. 16: Identify all studies, evaluations, reports, analyses, or other documents prepared by or for ITC^DeltaCom since January 1, 1996 that refer or relate to the out-of-service time for ITC^DeltaCom's end-users when any Incumbent Local Exchange Carrier, including BellSouth, provisions on unbundled loop to ITC^DeltaCom.

Response: This information was provided to BellSouth under the protection of the confidentiality agreement which was executed on August 13, 1999.

Interrogatory No. 17: Identify all studies, evaluations, reports, analyses, or other documents prepared by or for ITC^DeltaCom since January 1, 1996 that refer or relate to the out-of-service time for ITC^DeltaCom's end-users when any incumbent Local Exchange Carrier, including BellSouth, provisions multiple unbundled loops to ITC^DeltaCom.

Response: See Response to Interrogatory Number 16, above.

Interrogatory No. 18: Identify all studies, evaluations, reports, analyses, or other documents prepared by or for ITC^DeltaCom since January 1, 1996 that refer or relate to any

costs incurred by ITC^DeltaCom when a Firm Order Confirmation ("FOC") is modified by any Incumbent Local Exchange Carrier, including BellSouth.

Response: Actual costs are incurred on an individual case basis ("ICB"). It should also be noted that this interrogatory relates to a Petition issue that has been settled by the Parties.

Interrogatory No. 19: Identify all agreements between ITC^DeltaCom and an Incumbent Local Exchange Carrier under Section 252 of the Act, whether the agreement was entered into through voluntary negotiation or compulsory arbitration. In answering this request, please:

(a) identify the Incumbent Local Exchange Carrier that is a party to each such agreement;

(b) state the effective date of each such agreement; and

(c) state the expiration date of each such agreement.

Response: Other than the Interconnection Agreement with BellSouth, ITC^DeltaCom responds as follows:

(a) Southwestern Bell, Sprint and GTE.

(b)

Southwestern Bell -	Texas (8/25/99)
	Arkansas - (3/20/99)
Sprint -	1/11/99
GTE -	Alabama (10/17/98)
	Florida (5/99) (opt-in to AT&T/GTE agreement)

(c)

Southwestern Bell -	Arkansas - (1/7/2000)
Sprint -	(2/11/2000)
GTE -	Alabama (10/17/99)
	Florida (1/31/2000)

Interrogatory No. 20: Please state the total number of end user customers that ITC^DeltaCom serves within the State of Florida.

Response: ITC^DeltaCom objects on the grounds that the information requested is not relevant to any issue in the proceeding, nor is it reasonably calculated to lead to the discovery of admissible evidence. Furthermore, BellSouth is a direct competitor of ITC^DeltaCom and this information is highly confidential and proprietary.

Interrogatory No. 21: Please state the total number of end users customers that ITC^DeltaCom serves off of its own network ("on-net" customers) within Florida.

Response: See Response to Interrogatory Number 20, above.

Interrogatory No. 22: Please state the total number of ITC^DeltaCom's on-net customers in Florida that are Internet Service Providers ("ISPs").

Response: See Response to Interrogatory Number 20, above.

Interrogatory No. 23: Please state on a monthly basis the total amount of revenue that ITC^DeltaCom has received from providing services within Florida to its end-user customers.

Response: See Response to Interrogatory Number 20, above.

Interrogatory No. 24: Please state on a monthly basis the total amount of revenue that ITC^DeltaCom has received from providing services within Florida to its "on-net" end-user customers.

Response: See Response to Interrogatory Number 20, above.

Interrogatory No. 25: For the Florida ISP customers in Response to Interrogatory No. 22, please state, on an annual basis, (a) the total amount billed by ITC^DeltaCom for service to those customers from inception of service to present, (b) the amounts of any credit, rebate, or adjustments given to such customers, and (c) the total amount of revenue collected from such customers, from inception of service to present.

Response: See Response to Interrogatory Number 20, above.

Interrogatory No. 26: Please identify any cost study or other data or documents concerning the actual cost to ITC^DeltaCom to transport ISP traffic from the point of interconnection with BellSouth to the ISP server being served by an ITC^DeltaCom switch.

Response: ITC^DeltaCom has not, at this time, prepared such a study.

Interrogatory No. 27: State the number of end-user residential customers ITC^DeltaCom serves in Florida.

Response: ITC^DeltaCom objects on the grounds that the information requested is not relevant to any issue in the proceeding, nor is it reasonably calculated to lead to the discovery of admissible evidence. Furthermore, BellSouth is a direct competitor of ITC^DeltaCom and this information is highly confidential and proprietary.

Interrogatory No. 28: State the number of end-user business customers ITC^DeltaCom serves in Florida.

Response: See Response to Interrogatory Number 27, above.

Interrogatory No. 29: State the number of switches ITC^DeltaCom has deployed in Florida.

Response: ITC^DeltaCom's Florida customers are served by one switch at present.

Interrogatory No. 30: State the number of local service requests ITC^DeltaCom submitted to BellSouth manually in 1999.

Response: BellSouth controls this information and it is in their possession. Indeed, BellSouth submits monthly reports to ITC^DeltaCom with this information.

Interrogatory No. 31: State the number of local service requests ITC^DeltaCom submitted to BellSouth electronically in 1999.

Response: See Response to Interrogatory Number 30, above.

Interrogatory No. 32: State the number of resold lines ITC^DeltaCom has in Florida.

Response: See Response to Interrogatory Number 30, above.

Interrogatory No. 33: State the number of unbundled network elements ITC^DeltaCom has purchased in Florida.

Response: See Response to Interrogatory Number 30, above.

Interrogatory No. 34: Identify each performance measurement ITC^DeltaCom contends it needs in Issue 1(a).

Response: See Attachment 10 to ITC^DeltaCom's proposed Interconnection Agreement. (Exhibit A to the Petition).

Interrogatory No. 35: State with specificity the grounds upon which ITC^DeltaCom contends it is entitled to "performance guarantees" in Issue 1(a).

Response: See the pre-filed testimony of ITC^DeltaCom witnesses Rozycki, Thomas and Hyde.

Interrogatory No. 36: State with specificity the reasons ITC^DeltaCom contends that the performance measurements proposed by BellSouth are not adequate for ITC^DeltaCom, including a detailed explanation as to why ITC^DeltaCom contends it needs a unique set of performance measurements in its interconnection agreement.

Response: See Response to Interrogatory Number 34. BellSouth's proposals do not include any meaningful measurement of BellSouth's nonperformance. Most importantly, there is no commitment from BellSouth that it will meet any measurement. Through tariffs and Commission regulation, BellSouth provides credits and refunds to retail and access customers when it fails to meet an installation due date. In fact, BellSouth provides more "satisfaction" and "commitment" guarantees in Florida retail tariffs than we have found so far in other state tariffs. These tariff references are attached as rebuttal exhibits to Mr. Rozycki's testimony. It is unclear to ITC^DeltaCom why BellSouth refuses to offer similar guarantees to ITC^DeltaCom, a wholesale purchaser of local services, yet will offer such commitments to its retail and access customers.

Interrogatory No. 37: For each performance measurement proposed by ITC^DeltaCom in Issue 1(a), state how ITC^DeltaCom contends each measurement will demonstrate "nondiscriminatory access consistent with the requirements of the 1996 Act and the FCC orders and rules."

Response: See Response to Interrogatory Number 34, above.

Interrogatory No. 38: State with specificity the means by which ITC^DeltaCom proposes to apply the penalty, liquidated damages, or waiver described in Issue 1(b) if the missed due date is partially or fully the fault of ITC^DeltaCom.

Response: If the missed due date is the fault of ITC^DeltaCom or ITC^DeltaCom's customer, there will not be any penalty, liquidated damages, or waiver.

Interrogatory No. 39: State with particularity, including appropriate citations or other sources, each of the legal and/or regulatory grounds upon which you contend a penalty, liquidated damages or waiver is appropriate.

Response: ITC^DeltaCom objects to this question because it calls for a legal conclusion and is not appropriate for discovery. In response generally, the Telecommunication Act of 1996 and various discussions of federal and state regulations. See also ITC^DeltaCom's Pre-Hearing Statement.

Interrogatory No. 40: Do you agree that BellSouth sometimes misses due dates for its own retail customers? If not, explain.

Response: Yes.

Interrogatory No. 41: Does ITC^DeltaCom agree that missed due dates do not equate to nondiscriminatory access? If not, explain.

Response: Not necessarily. By missing due dates, BellSouth may not be providing ITC^DeltaCom nondiscriminatory access in violation of the Telecommunication Act of 1996.

Interrogatory No. 42: Explain with specificity the grounds upon which ITC^DeltaCom has rejected BellSouth's proposed language for Issue 2 regarding access to OSS, UNEs, White Page Listings and Access to Numbering Resources.

Response: Please refer to the pre-filed testimony of ITC^DeltaCom witnesses Rozycki, Hyde and Thomas.

Interrogatory No. 43: Define "parity" and provide legal, regulatory or other citations which support your definition. If your definition varies from any legal or regulatory requirements regarding "parity", your answer should also include a detailed explanation of the reason for such variance.

Response: The quality or state of being equal. The Telecommunications Act of 1996 requires "nondiscriminatory access" meaning that competitive local exchange carriers should not receive substandard access or service as compared to that which the incumbent provides to itself, its customers, its affiliates or any other carrier.

Interrogatory No. 44: Which electronic interfaces does ITC^DeltaCom currently use? Does ITC^DeltaCom have any plans to utilize the Telecommunications Access Gateway ("TAG") preordering and/or ordering electronic interfaces?

Response: See the pre-filed testimony of ITC^DeltaCom witness Thomas. ITC^DeltaCom is evaluating the additional costs and expense of implementing TAG, a completely different architecture than EDI. ITC^DeltaCom implemented EDI based on BellSouth's affirmation in the 271 hearings that EDI provides nondiscriminatory access to OSS to CLECs. Now, ITC^DeltaCom must implement TAG and is being required to absorb those costs as well as those of BellSouth.

Interrogatory No. 45: State with specificity the grounds upon which ITC^DeltaCom contends that TAG, which allows information contained in the customer service records ("CSRs") to be parsed (broken down into smaller segments) by the CLECs to the required level of detail, is not sufficient for parsing CSRs for ITC^DeltaCom.

Response: See the testimony of witness Thomas.

Interrogatory No. 46: State with specificity the grounds upon which ITC^DeltaCom contends that BellSouth fails to provide nondiscriminatory access to RSAG.

Response: See the testimony of witness Thomas.

Interrogatory No. 47: State with specificity the grounds upon which ITC^DeltaCom contends that notification of changes to BellSouth's business rules via BellSouth's Interconnection Web page is not fair and reasonable means of notice to CLECs.

Response: See the testimony of witness Thomas.

Interrogatory No. 48: State with specificity the grounds upon which ITC^DeltaCom contends it needs 45 days notice of changes to BellSouth's business rules as opposed to the 30 days notice BellSouth currently provides to all CLEC's.

Response: See the testimony of witness Thomas.

Interrogatory No. 49: Does ITC^DeltaCom utilize the BellSouth Interconnection Web page?

Response: Yes.

Interrogatory No. 50: State the means by which ITC^DeltaCom contends BellSouth should provide ITC^DeltaCom with an unbundled loop using IDLC technology in cases in which it is not technically feasible to provide such a loop.

Response: ITC^DeltaCom disagrees with the premise to this question. ITC^DeltaCom knows of no instance when it is not technically feasible to provide such a loop. See the pre-filed testimony of witness Hyde.

Interrogatory No. 51: Does ITC^DeltaCom contend that BellSouth does not provide ITC^DeltaCom with the specific transmission requirements it requests when it orders loops? If the answer is in the affirmative, state the following:

(a) identify with particularity the specific transmission requirements ITC^DeltaCom requested that BellSouth failed to provide;

(b) state the date when you first requested the specific transmission requirements and the date BellSouth allegedly failed to provide them;

(c) state the reasons purportedly given by BellSouth for its refusal to provide such specific transmission requirements;

(d) Identify each specific location where ITC^DeltaCom contends that BellSouth failed to provide facilities meeting the requested specific transmission requirements;

(e) identify all documents that refer or relate to ITC^DeltaCom's request for, or BellSouth's refusal to provide, specific transmission requirements.

Response: ITC^DeltaCom has not requested specific transmission requirements but expects that BellSouth will provide for each ITC^DeltaCom order the same technical specifications BellSouth provides to its retail customers. When an existing BellSouth customer converts to ITC^DeltaCom, ITC^DeltaCom expects that loop to perform at the same level and with the same specification that it had when used for BellSouth retail service.

Interrogatory No. 52: Does ITC^DeltaCom contend that BellSouth does not provide ITC^DeltaCom with unbundled loops using IDLC technology in cases in which it is technically feasible to provide such loops? If so, explain.

Response: Yes. ITC^DeltaCom is not aware that BellSouth has proven to any state or federal regulatory authority that it is not technically feasible to provide IDLC. BellSouth has the burden of showing that it is not technically feasible.

Interrogatory No. 53: State with specificity the means by which ITC^DeltaCom proposes that BellSouth administer the repair and maintenance guidelines referenced in Issue 2(b)(i) without BellSouth knowing the identity of the end-user. If ITC^DeltaCom contends that

it plans to provide BellSouth with the identity of the end-users, stated in detail how ITC^DeltaCom proposes to do so.

Response: See the testimony of ITC^DeltaCom witnesses Thomas and Hyde. Based on recent negotiations with BellSouth, it is ITC^DeltaCom's understanding that it can use the same "priority" classifications that BellSouth utilizes today. In this case, ITC^DeltaCom would not be required to provide the actual identity of the end-user but only the category or classification that the end-user falls into. It should be noted that this interrogatory relates to a Petition Issue that has been resolved by the Parties.

Interrogatory No. 54: In Issue 2(b)(i), ITC^DeltaCom proposes that it "will inform" BellSouth if the repair problem is associated with a high priority needs customer. Does ITC^DeltaCom propose for that notification to be made manually or electronically? To whom does ITC^DeltaCom propose that the notification be sent?

Response: ITC^DeltaCom proposes that it will inform BellSouth of the repair problem associated with a high priority needs customer via the same method that it notifies BellSouth of repair problems today. However, if alternative arrangements are necessary, ITC^DeltaCom is open to further negotiations. It should be noted that this interrogatory relates to a Petition Issue that has been settled by the Parties.

Interrogatory No. 55. State with specificity all "combinations", including UNES and/or services, that ITC^DeltaCom contends it is entitled to be provided by BellSouth.

Response: ITC^DeltaCom contends that it should be permitted to continue ordering extended loops in the same manner that was implemented under our existing approved

interconnection agreement (Section IV. B.14 page 6) pending the final determination of the FCC on unbundled network elements and in light of the Supreme Court's decision on combinations. See also, the FCC's recent September 15, 1999 press release regarding unbundled network elements.

Interrogatory No. 56: State with specificity the UNE combinations to which ITC^DeltaCom contends it is entitled to be provided in BellSouth's network.

Response: See the Petition and the FCC's recent September 15, 1999 press release.

Interrogatory No. 57: Provide all legal, regulatory or other authority that you contend supports ITC^DeltaCom's answer to Interrogatories 55 and 56.

Response: Our existing interconnection agreement approved by this Commission required BellSouth to negotiate in good faith to develop a method for extended loops. BellSouth did provide extended loops to ITC^DeltaCom. In fact, BellSouth has provided over 2500 extended loops to ITC^DeltaCom regionwide. Based on the authority of the Florida Commission to regulate local services provided in Florida and based on BellSouth's letter to the FCC dated February 11, 1999, wherein BellSouth promises to continue providing every unbundled network element it currently affords under its existing interconnection agreements. See also, the FCC's recent September 15, 1999 press release.

Interrogatory No. 58: How do you contend the term "currently combined" should be construed? In answering this Interrogatory, identify all facts and documents that support this contention, including all legal, regulatory, or other citations which support your contention.

Response: See the testimony of ITC^DeltaCom witness Wood.

Interrogatory No. 59: For each UNE combination that you contend BellSouth should be required to provide, explain in detail what activities you contend are required for BellSouth to provide that combination to a requesting carrier. In answering this Interrogatory, describe with particularity:

(a) the basis for your explanation, including identifying any studies, evaluations, reports or analyses upon which your explanation is based;

(b) any differences in these activities depending upon the type of combinations of unbundled elements being provided.

Response: ITC^DeltaCom submits that all such activities should be covered in BellSouth's Cost Study. ITC^DeltaCom has received that study and is currently reviewing its contents.

Interrogatory No. 60: State with specificity the grounds upon which ITC^DeltaCom rejected BellSouth's offer of a loop cutover installation interval time of fifteen (15) minutes for a single circuit conversion with multiple loop cutovers being accomplished in increments of time per loop.

Response: BellSouth's offer does not meet the parity requirements of the Act and FCC Rules and is a significant departure from the current agreement.

Interrogatory No. 61: Does ITC^DeltaCom dispute that it takes more time to provision a multiple loop cutover than to provision a single circuit conversion? If so, explain.

Response: If BellSouth performs the pre-testing that they have agreed to do, a multiple cutover may take essentially the same time as a single loop cutover. See the testimony of witness Hyde.

Interrogatory No. 62: Identify each and every fact and actual instance, including date, location and numbers/codes involved, that supports ITC^DeltaCom contention in Issue 2(c)(i) that "BellSouth improperly loaded NXX codes on many occasions."

Response: Enclosed are the most recent translations troubles reported to BellSouth region wide from approximately June 1999 to September 1999. In addition, BellSouth has access and was a party to Docket 25835 (Alabama Public Service Commission) wherein Mr. Steven D. Moses testified and provided data regarding problems with NXX codes being improperly loaded and accompanying translations problems.

Interrogatory No. 63: State each and every reason ITC^DeltaCom has not accepted BellSouth's proposed NXX testing method described in response to Issue 2(c)(i).

Response: See testimony of witness Hyde. BellSouth has proposed that ITC^DeltaCom purchase an fx line to each and every BellSouth end office which is inefficient and cost prohibitive. In addition, ITC^DeltaCom has provided BellSouth with **three** proposals. First , ITC^DeltaCom requested access to BellSouth's testing platform as specified in our current interconnection agreement. BellSouth rejected ITC^DeltaCom's first proposal. ITC^DeltaCom then proposed a switch based testing platform. However, BellSouth rejected this second proposal because its Lucent switches are not currently capable of providing the needed

functionality. ITC^DeltaCom is now waiting for BellSouth's response to ITC^DeltaCom's third proposal. This third proposal is discussed more fully in Mr. Hyde's testimony.

Interrogatory No. 64: With respect to Issue 2(c)(v), would ITC^DeltaCom agree to compensate BellSouth for the costs incurred in hiring/assigning a designated contact for ITC^DeltaCom? If the answer is yes, with qualifications, delineate each of those qualifications.

Response: Generally, yes. The response to this question depends upon the precise offer made by BellSouth. BellSouth's cost study contemplates that a BellSouth technician can only coordinate six loops per day. ITC^DeltaCom averages many more loops than six and therefore should already be assigned BellSouth personnel as designated contacts.

Interrogatory No. 65: State with specificity the details of ITC^DeltaCom's proposal in Issue 2(c)(vi) that each party should reimburse the other for any additional costs incurred for isolating the trouble to the other's network.

Response: Recovery of costs on a time and materials basis of all costs incurred by ITC^DeltaCom to isolate the same trouble to BellSouth's network each subsequent time until BellSouth repairs the problem. No charges would apply for the first referral.

Interrogatory No. 66: What costs does ITC^DeltaCom propose to recover in Issue 2(c)(vi).

Response: See response to # 65

Interrogatory No. 67: How does ITC^DeltaCom propose to calculate the costs it proposes to recover in Issue 2(c)(vi).

Response: See response to # 65

Interrogatory No. 68: State with specificity the reasons or grounds that ITC^DeltaCom contends that BellSouth should designate an order as a.m. or p.m. when no access to the customer premise is required and the end-user is indifferent as to the time of service?

Response: ITC^DeltaCom will not request a.m. or p.m. designation if the end-user is indifferent as to the time of service

Interrogatory No. 69: State all legal and/or regulatory grounds that support ITC^DeltaCom's contention in Issue 2(c)(viii) that BellSouth must be required to maintain and repair at industry standards a loop that has been modified.

Response: Sections 251 and 252 of the Telecommunications Act of 1996 and the FCC Rules.

Interrogatory No. 70: In what situations does ITC^DeltaCom contend in Issue 2(c)(x) that BellSouth would modify an order after sending a FOC?

Response: BellSouth frequently modifies the due date on orders after sending an FOC. However, it should be noted that the Parties settled this issue by agreeing to remove sections

Sections 2.2.2.7 and 2.2.2.8 in their entirety and thereby close Issue 2(c)(x).

Interrogatory No. 71: State with specificity each and every time you contend the situation you described in answer to the preceding Interrogatory has occurred. Provide detailed facts, including the date of such occurrence, order number (including telephone numbers) and the outcome of such situation.

Response: The data requested is not available in the format requested. See response to Interrogatory 70.

Interrogatory No. 72: What costs does ITC^DeltaCom contend it incurs in Issue 2(c)(x)?

Response: Actual costs are incurred on an individual case basis. See response to Interrogatory 70.

Interrogatory No. 73: How does ITC^DeltaCom propose to calculate the costs it contends it incurs in Issue 2(c)(x)?

Response: Actual costs are incurred on an individual case basis. See response to Interrogatory 70.

Interrogatory No. 74: Does ITC^DeltaCom dispute that with respect to UNE conversions, dial tone is strictly a function of the CLEC and is not a responsibility of BellSouth? If so, explain in detail all facts which give rise to ITC^DeltaCom's answer.

Response: Not necessarily. The dial tone tests that ITC^DeltaCom has requested uses ITC^DeltaCom's dial tone to test continuity in BellSouth's network.

Interrogatory No. 75: State with specificity what ITC^DeltaCom is seeking when it contends that BellSouth should be required to perform dial tone tests at least 48 hours prior to the scheduled cutover date in Issue 2(c)(xiv).

Response: See response to #74

Interrogatory No. 76: State the grounds upon which ITC^DeltaCom contends it is necessary to define "flow-through" in the parties' interconnection agreement.

Response: Contracts should be unambiguous where possible. Other terms are defined. ITC^DeltaCom seeks to avoid post-arbitration disputes over the meaning of "flow through." See the testimony of witness Thomas.

Interrogatory No. 77: State the grounds, if any, upon which ITC^DeltaCom contends BellSouth's LNP cutover procedures are inadequate and provide detailed explanation of each and every change in such procedures ITC^DeltaCom contends is needed.

Response: ITC^DeltaCom has not requested BellSouth to change its procedures only that BellSouth *fully* implement and follow its procedures. ITC^DeltaCom has proposed the following contract language to ensure that consumers do not experience quality of service problems because of LNP cutovers:

The Parties shall ensure that users of telecommunications services are able to retain, at the same location or at another location served by the same wire center existing numbers without impairment of quality, reliability, or convenience when switching from one Party to the Other. BellSouth shall insure that the disconnect order is completed for all ported numbers once the NPAC notification of ITC^DeltaCom's activate Subscription Version has been received by

BellSouth. BellSouth shall use best efforts to insure that the disconnect order is worked within 15 minutes of receiving the NPAC notice, but in no circumstances shall exceed two hours. Where the loop is being purchased by ITC^DeltaCom as an unbundled network element or as an access facility, prior to the time of LNP implementation, BellSouth shall provide an operations contact whom ITC^DeltaCom can reach in the event manual intervention is needed to complete the cutover. In the event of manual intervention, completion will be negotiated by the Parties.

Interrogatory No. 78: State the rate you contend is appropriate for reciprocal compensation for ISP-bound traffic, and separately state the rate you contend is appropriate for local traffic. In answering this Interrogatory, state with particularity how the rate(s) were calculated and identify any analyses, cost studies, or other reports that support your rate.

Response: See the testimony of witnesses Rozycki and Wood.

Interrogatory No. 79: Does ITC^DeltaCom route calls to ISPs over local trunks?

Response: Yes, as does BellSouth.

Interrogatory No. 80: Does ITC^DeltaCom route access, toll or other non-local traffic over its local trunks?

Response: ITC^DeltaCom does not route access, toll or other non-local traffic over one way trunks. ITC^DeltaCom does route tandem access over the two way trunks. BellSouth, however, apparently does route access, toll, and other non-local traffic over one way and two way trunk groups.

Interrogatory No. 81: What are the hours of operation for ITC^DeltaCom's service representatives?

Response: 24 hours a day, seven days a week.

Interrogatory No. 82: Does ITC^DeltaCom dispute the fact that once a UNE facility is disconnected for any reason, it is subject to immediate reuse by another provider? If so, please fully explain.

Response: Not necessarily. However, if BellSouth disconnects by error, BellSouth must immediately restore the disconnected service. Also, in cases involving slamming complaints, ITC^DeltaCom expects that BellSouth will work cooperatively to immediately restore service to the authorized provider.

Interrogatory No. 83: Does ITC^DeltaCom contend that every time it submits a disconnect order, BellSouth should reserve the facilities used by the ITC^DeltaCom customer for ITC^DeltaCom's later use?

Response: No.

Interrogatory No. 84: Cite the provisions of the FCC's recent Advanced Services Order that ITC^DeltaCom contends obligates BellSouth to provide cageless collocation within 30 days after a firm order is placed.

Response: The FCC Advanced Services Order does not specify a specific time frame. However, cageless collocation is equivalent to virtual collocation which BellSouth today

provides in thirty to forty-five days. Therefore, BellSouth should provide cageless collocation in 30 to 45 days.

Interrogatory No. 85: State each and every fact upon which ITC^DeltaCom relies in making the allegation in Issue 4(c) that ITC^DeltaCom is subject to stricter security requirements than those applied to BellSouth's approved third party vendors.

Response: ITC^DeltaCom contacted Six R Communications, an outside vendor, used by BellSouth and learned that although they do background checks, Six R does not currently transmit information concerning their personnel directly to BellSouth. However, it should be noted that the Parties have resolved the Petition Issue related to this interrogatory.

Interrogatory No. 86: Does ITC^DeltaCom contend in Issue 6(c) that BellSouth incurs no costs in connection with a disconnection?

Response: When an end user switches providers, BellSouth contemplates charging a connect and disconnect charge for the same function. In those cases, only the connect function would apply. See testimony of Wood.

Interrogatory No. 87: State with specificity the grounds for ITC^DeltaCom's alleged concern in Issue 6(c) that BellSouth will recover its costs twice.

Response: See Response to Number 86.

Interrogatory No. 88: State all legal and/or regulatory grounds that you contend support your position that BellSouth is not permitted to impose charges for its OSS.

Response: See testimony of witness Wood.

Interrogatory No. 89: State each and every reason ITC^DeltaCom will not accept the procedures documented in the MECAB and MECOD OBF Guidelines for Meet Point Billing for situations in which such standards are applicable.

Response: ITC^DeltaCom is not aware of any situation in which the MECAB and MECOD OBF Guidelines for Meet Point Billing of transport would be applicable as part of an interconnection agreement between ITC^DeltaCom and BellSouth. Transport is the only access billing element with a "billing percentage." In addition, BellSouth interconnects with ITC^DeltaCom at ITC^DeltaCom's collocation space located at BellSouth's tandem switch for access traffic to IXCs. ITC^DeltaCom then transports the call to (or from) ITC^DeltaCom's switch. Therefore, should any such transport "meet point" applicability occur, the billing percentage would be 100% ITC^DeltaCom. The MECAB/MECOD OBF Guidelines assumes instances of less than 100% for meet point billing. In other words, when one party provides all of the facility, then there cannot be a facility "meet point" with another party.

As noted above, ITC^DeltaCom's "meet point" with BellSouth is at the collocation space in BellSouth's tandem switch office. ITC^DeltaCom bills the IXC for local switching, common line charges and transport. BellSouth bills the IXC for tandem switching and entrance facilities. This procedure is in compliance with the MECAB/MECOD Guidelines.

Interrogatory No. 91: Is it Mr. Hyde's contention on page 4 of his direct testimony in ITC^DeltaCom's Florida arbitration proceeding that BellSouth never provides ITC^DeltaCom with IDLC?

Response: ITC^DeltaCom has recently been made aware that BellSouth is providing IDLC in rare circumstances. ITC^DeltaCom is currently aware of one loop in Alabama that is IDLC and three or four in South Carolina. ITC^DeltaCom was not informed by BellSouth that these facilities were being installed as IDLC. ITC^DeltaCom is not aware of any IDLC being provided by BellSouth in Florida.

Interrogatory No. 92: On page 6 of Mr. Hyde's direct testimony in ITC^DeltaCom's Florida arbitration proceeding Mr. Hyde references "a common complaint" of ITC^DeltaCom customers. Identify each such complaint with specificity and (pursuant to protective order if necessary) state (a) each customer by whom this complaint was made; (b) the date of the complaint; (c) the date ITC^DeltaCom referred the situation to BellSouth; (d) BellSouth's response; and (e) identify all documents referring, relating or pertaining to these alleged complaints.

Response: As discussed in the Direct Testimony of ITC^DeltaCom witness Thomas Hyde, customers that were served by BellSouth via Integrated Digital Loop Carrier ("IDLC") that switched to ITC^DeltaCom and were served by a substandard UNE loop using outdated UDLC technology have registered complaints regarding degraded modem performance. BellSouth seeks the name of such customers, the date of the complaint, the date ITC^DeltaCom referred the complaint to BellSouth, BellSouth's response to such complaint, and all relevant documents. To compile such data, ITC^DeltaCom must track through many records, some of

which are in its sales offices. ITC^DeltaCom is in the process of compiling such information and hopes to have such information prior to the hearing.

As a supplement to this request, ITC^DeltaCom attaches Technical Papers prepared by 3Com (Exhibit "A"), one of the world's leading producers of modem technology, regarding specifications for V.90 digital modem requirements. These Technical Papers help explain the problems experienced by ITC^DeltaCom customers being served by UNE UDLC loops. On page 4 of the Technical Papers, under the heading of V.90 Requirements, 3Com sets forth several conditions that must exist for full 56 Kbps transmission using a V.90 digital modem, one of which is that there can be only one analog-to-digital conversion in the phone network along a path of the call between the V.90 digital modem and the analog modem. As further explained in the testimony of ITC^DeltaCom witness Thomas Hyde, when BellSouth changes a customer whom BellSouth serves via IDLC to an UNE UDLC loop, BellSouth causes two *additional* analog-to-digital conversions to occur in the network. These two additional analog-to-digital conversions will, and do, cause modem impairment in all cases where UDLC is used in lieu of IDLC. This is the source of the customer complaints to which Mr. Hyde refers.

Interrogatory No. 93: Identify with specificity each and every instance Mr. Hyde references on page 6 of his direct testimony filed in ITC^DeltaCom's Florida arbitration proceeding in which he contends the customer had a certain modem speed with ITC^DeltaCom and the modem speed increased when the customer switched to BellSouth.

Response: See Response to Interrogatory number 92.

Interrogatory No. 94: State with specificity each and every instance Mr. Hyde references on page 10 of his direct testimony filed in ITC^DeltaCom's Florida arbitration proceeding in which BellSouth is "double billing" ITC^DeltaCom for the extended loops it provisioned for ITC^DeltaCom.

Response: BellSouth has issued a credit of $275,000 to ITC^DeltaCom; however, there is still some dispute as to whether additional credits should be provided.

Interrogatory No. 95: On pages 11-12 of Mr. Hyde's direct testimony in ITC^DeltaCom's Florida arbitration proceeding Mr. Hyde references alleged problems with the loops provided by BellSouth to ITC^DeltaCom. Identify each such problem with specificity and (pursuant to protective order if necessary) state (a) each customer by whom this complaint was made; (b) the date of the complaint; (c) the date ITC^DeltaCom referred the situation to BellSouth; (d) BellSouth's response; and (e) identify all documents referring, relating or pertaining to these alleged complaints.

Response: To the extent this information is available it has been provided to BellSouth subject to a confidential and proprietary agreement.

Interrogatory No. 96: Of the 62% of the orders that Michael Thomas contends fall out for manual handling on page 3 of his direct testimony filed in ITC^DeltaCom's Florida arbitration proceeding, what percentage of those fall out due to errors by ITC^DeltaCom?

Response: The 62 % fallout refers to the orders that are not LESOG eligible and is not caused or related to whether the orders contain errors by either BellSouth or ITC^DeltaCom. LESOG eligible means that the orders are capable of LESOG flowthrough.

Interrogatory No. 97: Does ITC^DeltaCom contend that BellSouth will not schedule after-hours cutovers?

Response: No.

Dated this 27 day of September, 1999.

J. Michael Huey (Fla. Bar # 0130971)
J. Andrew Bertron, Jr. (Fla. Bar # 982849)
Huey, Guilday & Tucker, P.A.
106 E. College Ave., Suite 900 (32301)
Post Office Box 1794
Tallahassee, Florida 32302
850/224-7091 (telephone)
850/222-2593 (facsimile)

David I. Adelman, Esq.
Sutherland, Asbill & Brennan, LLP
999 Peachtree Street, N.E.
Atlanta, Georgia 30309
(404) 853-8206

Nanette S. Edwards, Esq.
Regulatory Attorney
ITC^DeltaCom
700 Boulevard South, Suite 101
Huntsille, Alabama 35802
(256) 382-3957

Attorneys for ITC^DeltaCom

CERTIFICATE OF SERVICE

I hereby certify that a true and correct copy of the foregoing has been furnished this 27 day of September, 1999 to the following:

Diana Caldwell
Staff Counsel
Florida Public Service Commission
Division of Legal Services
2540 Shumard Oak Blvd.
Tallahassee, Florida 32399-0850
(hand delivery)

Nancy B. White
Michael P. Goggin
BellSouth Telecommunications, Inc.
150 South Monroe Street
Suite 400
Tallahassee, Florida 32301
(hand delivery)

R. Douglas Lackey
Thomas B. Alexander
E. Earl Edenfield, Jr.
BellSouth Telecommunications, Inc.
Suite 4300, BellSouth Center
675 W. Peachtree Street, N.E.
Atlanta, Georgia 30375
(overnight delivery)

Attorney

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I, Nanette S. Edwards, as authorized representative of ITC^DeltaCom Communications, Inc., do hereby depose and state that the foregoing Answers to BellSouth Telecommunications, Inc.'s First Set of Interrogatories are true and correct to the best of my knowledge and belief.

Dated this 23rd day of Sept., 1999.

Nanette S. Edwards
Print Name: Nanette S. Edwards

STATE OF Alabama
COUNTY OF Madison

The foregoing instrument was acknowledged before me this 23rd day of September, 1999, by Nanette S. Edwards who is personally known to me or who has produced the following Answers as identification and who did take an oath that the foregoing answers set forth to the foregoing interrogatories are true and correct to the best of his/her knowledge and belief.

Rose N. Hatt
NOTARY PUBLIC
My Commission Expires: 04/23/00
(SEAL)

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3Com Technical Papers

3Com V.90 Technology

EXHIBIT A

3Com V.90 Technology

Contents

3Com V.90 Technology

V.90, a data transmission recommendation developed by Study Group 16 of the International Telecommunications Union (ITU), provides a specification for achieving line speeds of up to 56 Kbps. This paper explains V.90 in detail.

V.90 technology allows modems to receive data at up to 56 Kbps over the standard public switched telephone network (PSTN). V.90 overcomes the theoretical limitations imposed on standard analog modems by exploiting the digital server connections that most Internet and online service providers use at their end to connect to the PSTN.

Typically, the only analog portion of the phone network is the phone line that connects the remote site to the telephone company's central office (CO). Over the past two decades, local telephone companies have been replacing portions of their original analog networks with digital circuits. But the slowest portion of the network to change has been the connection from the home to the CO. That connection will likely remain analog for some years to come.

A software upgrade converts a service provider's 3Com Total Control™ remote access concentrator, SuperStack® II Remote Access System 1500 with Universal Connect™ technology, NETServer I-modems, or U.S. Robotics® MP I-modems to V.90 operation. 3Com calls the modems that have a direct digital connection to the PSTN V.90 *digital modems.* Likewise, converting a U.S. Robotics Courier™ V.Everything® analog modem to a V.90 *analog modem* is as simple as downloading new software.

V.34 Encoding in More Detail

The PSTN was designed for voice communications (Figure 1). By artificially limiting the sound spectrum to just those frequencies relevant to human speech, network engineers found they could reduce the bandwidth needed per call, increasing the number of potential simultaneous calls. While this works well for voice, it imposes limits on data communications.

V.34 modems are optimized for the situation where both ends connect by analog lines to the PSTN. Even though most of the network is digital, V.34 modems treat it as if it were entirely analog. V.34 modems are incredibly robust, but they cannot make the most of the bandwidth that becomes available when one end of the connection is completely digital. V.34 was built on the assumption that both ends of the connection suffer impairment due to quantization noise introduced by analog-to-digital converters (ADCs).

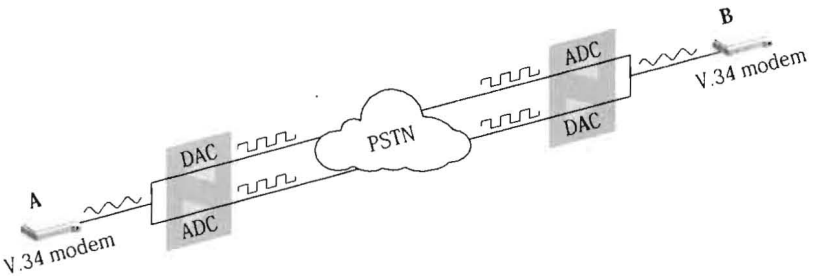

Figure 1. *Anatomy of a V.34 Connection*

Signal-to-Noise Ratio (SNR)

Signal-to-noise ratio is a measure of link performance arrived at by dividing signal power by noise power. The higher the ratio, the clearer the connection, and the more data can be passed across it. Even under the best conditions, when a signal undergoes analog-to-digital conversion, there is a 38 to 39 dB signal-to-noise ratio (the "noise floor"), which limits practical V.34 speeds to 33.6 Kbps.

Upstream and Downstream Channels: Asymmetric Operation

V.90 connections employ one bidirectional channel, upstream and downstream. The V.90 analog modem's downstream (receive) channel is capable of higher speeds because no information is lost in the digital-to-analog conversion. The V.90 analog modem's upstream (send) channel goes through an analog-to-digital conversion, which limits it to V.34 speeds.

Noise Introduced by Quantization of Analog Signals

Analog information must be transformed to binary digits in order to be sent over the PSTN. The incoming analog waveform is sampled 8,000 times per second, and each time its amplitude is recorded as a pulse code modulation (PCM) code. The sampling system uses 256 discrete 8-bit PCM codes.

Because analog waveforms are continuous and binary numbers are discrete, the digits that are sent across the PSTN and reconstructed at the other end can only approximate the original analog waveform. The difference between the original waveform and the reconstructed quantized waveform is called quantization noise, and it limits modem speed.

V.90 Encoding in More Detail

Quantization noise limits the V.34 communications channel to about 35 Kbps. But quantization noise affects only analog-to-digital conversion—not digital-to-analog. This is the key to V.90: if there are no analog-to-digital conversions between the V.90 digital modem and the PSTN, and if this digitally connected transmitter uses only the 255 discrete signal levels available on the digital portion of the phone network, then this exact digital information reaches the analog modem's receiver, and no information is lost in the conversion processes.

Here's how the process (Figure 2) works:

1. The server connects, in effect, digitally to the telephone company trunk.
2. The server signaling is such that the encoding process uses only the 256 PCM codes used in the digital portion of the phone network. In other words, there is no quantization noise associated with converting analog-type signals to discrete valued PCM codes.
3. These PCM codes are converted to corresponding discrete analog voltages and sent to the analog modem via an analog loop circuit, with no information loss.
4. The client receiver reconstructs the discrete network PCM codes from the analog signals it received, decoding what the transmitter sent.

Data is sent from the V.90 digital modem over the PSTN as binary numbers. But to meet the conditions of step 2 above, the V.90 digital modem transmits data (eight bits at a time) to the client's ADC at the same rate as the telephone network (8,000 Hz). This means the modem's symbol rate must equal the phone network's sample rate.

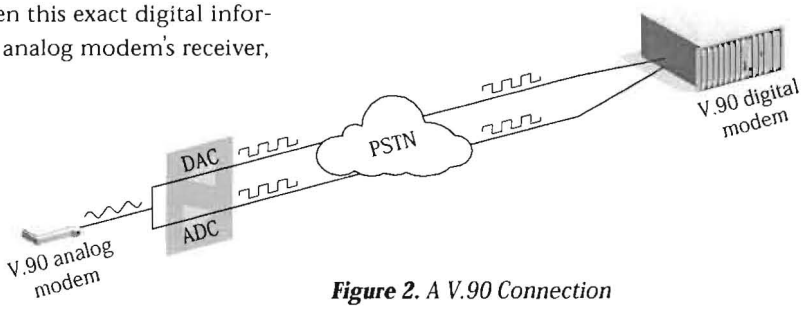

Figure 2. *A V.90 Connection*

V.90 Modem Connections

During the training sequence, V.90 modems probe the line to determine whether any downstream analog-to-digital conversions have taken place. If the V.90 modems detect any analog-to-digital conversions, they will simply connect as V.34. The V.90 analog modem also attempts a V.34 connection if the remote modem does not support V.90.

The V.90 analog modem's task is to discriminate among the 256 potential voltages, to recover 8,000 PCM codes per second. If it could do this, then the download speed would be nearly 64 Kbps (8,000 x 8 bits per code). But it turns out that several problems slow things down slightly.

First, even though the network quantization noise floor problem is removed, a second, much lower noise floor is imposed by the network digital-to-analog converter (DAC) equipment and the local loop service to the client's premises. This noise arises from various nonlinear distortions and circuit crosstalk.

Second, network DACs are not linear converters, but follow a conversion rule (μ-law in North America and A-law in many other places). As a result, network PCM codes representing small voltages produce very small DAC output voltage steps, whereas codes representing large voltages produce large voltage steps.

These two problems make it impractical to use all 256 discrete codes, because the corresponding DAC output voltage levels near zero are just too closely spaced to accurately represent data on a noisy loop. (Note: Each network PCM code corresponds to a DAC voltage level.) Therefore, the V.90 encoder uses various subsets of the 256 codes that eliminate DAC output signals most susceptible to noise. For example, the most robust 128 levels are used for 56 Kbps, 92 levels to send 52 Kbps, and so on. Using fewer levels provides more robust operation, but at a lower data rate.

V.90 Requirements

V.90 requires the following three conditions for full 56 Kbps transmission:

1. **Digital at one end.** Today, most service providers have digital connections to the PSTN. One end of an V.90 connection must terminate at a digital circuit, meaning a "trunk-side" channelized T1, ISDN PRI, or ISDN BRI. "Line-side" T1 will not work because additional analog-to-digital and digital-to-analog conversions are added. In a trunk-side configuration, once the user's analog call is converted to digital and sent through the carrier network, the call stays digital until it reaches a digital modem through a T1, PRI, or BRI circuit.

2. **V.90 support at both ends.** V.90 must be supported on both ends of the connection, by the analog modem as well as by the remote access server or modem pool at the host end. Typically, the remote user will be using a 3Com Courier, U.S. Robotics, Megahertz®, or other brand V.90 modem dialing into a 3Com U.S. Robotics MP I-modem, NETServer I-modem, Courier I-modem, SuperStack II Remote Access System 1500, Total Control remote access concentrator, or other brand V.90 digital modem.

3. **One analog-to-digital conversion.** There can be only one analog-to-digital conversion in the phone network along the path of the call between the V.90 digital modem and the analog modem. If the line is a channelized T1, it must be "trunk-side" and not "line-side." With line-side service from the phone company, there is typically an additional analog-to-digital conversion.

3Com x2™ Technology vs. 3Com V.90 Technology

Until recently, proprietary implementations were the only options for 56 Kbps access. However, in February 1998 the ITU reached a determination for 56 Kbps technology, providing for one universally compatible solution—the V.90 standard. 3Com's V.90 solution will remain compatible with 3Com's proprietary transmission scheme for 56 Kbps access, x2™ technology.

As Table 1 illustrates, all 3Com x2 modems, both client and server, will continue to support x2 technology when they are upgraded to V.90. Users who do not upgrade to the new standard will be able to connect to digital modems with 3Com's x2 technology for high-speed downloads. Client x2 modems that are not upgraded to the standard will receive a V.34 connection when they call a digital modem that was originally K56flex, even if it has been upgraded to the standard.

The Difference Is in the Details

The data modes of x2 technology and V.90 are essentially the same. The technical differences between x2 technology and V.90 are primarily in two areas of the "handshake" or initialization sequences:

- **V.8 Signaling Protocol.** V.8 is an international standard that determines the capabilities of the modems on both ends of the call. The V.8 signaling protocol used in V.90 differs from the proprietary signaling method used in x2 technology.
- **Digital Impairment Learning (DIL).** Digital Impairment Learning is a mechanism employed in V.90 technology that allows each manufacturer to determine the digital impairments in its own way. This method allows for flexibility and future improvements without a change to the protocol.

Table 1. *Modem Compatibility Matrix*

	x2 Server	K56flex Server	3Com V.90 Server	Other V.90 Server	V.34 Server
x2 Client	56K	V.34	56K	V.34	V.34
K56flex Client	V.34	56K	V.34	?*	V.34
3Com V.90 Client	56K	V.34	56K	56K	V.34
Other V.90 Client	V.34	?*	56K	56K	V.34
V.34 Client	V.34	V.34	V.34	V.34	V.34

** Backward compatibility is up to individual manufacturers*

V.90 Technology from 3Com

There are a number of important benefits to choosing 3Com's V.90 modem technology:

- **Digital connections today.** 3Com digital modems, such as those in the Total Control remote access concentrator, already process digital signals straight from digital lines, and can be upgraded to V.90 operation via a software upgrade.
- **Programmable platform.** 3Com has a long history of delivering software-based implementations based on digital signal processors (DSPs), and was the first to deliver 56 Kbps products to the market with U.S. Robotics x2 technology. 3Com has taken advantage of this lead to refine, enhance, and improve its 56 Kbps product line in order to deliver top performing products and easy upgrades for its customers.
- **Overcoming digital impairments/universal PAD detection.** 3Com has repeatedly developed technology that overcomes impairments on the telephone network. In previous protocols—V.34, for example—the industry faced analog impairments such as echo, line noise, and cross-talk. Common digital impairments include network signals (such as robbed bits), transcoding (A-law to μ-law conversion), and digital devices called packet assembler/disassemblers (PADs). If not properly compensated for in PCM modem algorithms, these digital impairments can change the digital bit stream enough to impact performance. The V.90 specification sets a framework and mechanism to allow for discovering and compensating for digital impairments, but it leaves the task of overcoming them to individual vendors.

3Com has designed and built true digital modems for years. Our engineers have spent the past year researching obscure impairments and variations and identifying solutions. 3Com has developed technology to overcome digital impairments and achieve maximum performance on the widest variety of transmission lines across the globe. V.90 modems from 3Com and its licensees will deliver the benefits of this research and development. ☐

Glossary

amplitude
A measure of the distance between the high and low points of a waveform.

analog-to-digital converter (ADC)
A device that samples incoming analog voltage waveforms, rendering them as sequences of binary digital numbers. Passing waveforms through an ADC introduces quantization noise.

Basic Rate Interface (BRI)
An ISDN line that provides up to two 64 Kbps B-channels and one 16 Kbps D-channel over an ordinary two-wire telephone line. B-channels carry circuit-oriented data or voice traffic while D-channels carry call-control signals.

call-control signaling
Operations associated with establishing and tearing down virtual circuits through a network; for example, dialing.

central office (CO)
The facility at which individual telephone lines in a limited geographic area are connected to the public telephone network.

Digital Impairment Learning (DIL)
A mechanism during the initial training sequence that allows for uploading and sending tones that allow the client analog modem to detect and learn about digital impairments in the path. This allows the analog modem to build a custom constellation that can avoid or compensate for the discovered impairments.

digital signal processor (DSP)
A processor that is optimized for performing the complex mathematical calculations inherent in processing digital signals. A discrete DSP can be reprogrammed; a DSP integrated in a chipset typically contains its own ROM and cannot be reprogrammed.

digital-to-analog converter (DAC)
A device that reconstructs analog voltage waveforms from an incoming sequence of binary digits; does not in itself introduce noise.

Integrated Services Digital Network (ISDN)
A public switched digital network that provides a wide variety of communications services and integrated access to the network

line-side T1
A T1 that undergoes at least one analog-to-digital conversion in the path between the V.90 digital modem and the PSTN.

Primary Rate Interface (PRI)
A four-wire ISDN line (or "trunk") with the same capacity as a T1, 1.544 Mbps. PRIs contain 23 64 Kbps B-channels and one 64 Kbps D-channel. The D-channel carries call-control signaling for all the B-channels.

public switched telephone network (PSTN)
The public networks that deliver telephone services worldwide.

pulse code modulation (PCM)
A technique for converting an analog signal with an infinite number of possible values into discrete binary digital words that have a finite number of values. The waveform is sampled, then the sample is quantized into PCM codes.

quantization
The process of representing a voltage with a discrete binary digital number. Approximating an infinite valued signal with a finite number system introduces an error called quantization error.

signal-to-noise ratio (SNR)
A measure of link performance arrived at by dividing signal power by noise power. Typically measured in decibels. The higher the ratio, the clearer the connection.

T1
A four-wire digital line (or "trunk") with the same capacity as a PRI line, 1.544 Mbps. T1s contain 24 DS-0s, each of which carries 56 Kbps (call-control signaling is carried within the DS-0).

trunk-side T1
A T1 line that has a direct digital connection to the phone network, and therefore undergoes no analog conversions in the path between the V.90 digital modem and the PSTN.

V.90 analog modem
A modem equipped with V.90 software and attached to a standard analog telephone line. In order to connect at V.90 speeds (32–56 Kbps), the device at the other end of the connection must be a V.90 digital modem that is attached to a trunk-side T1, BRI, or PRI line.

V.90 digital modem
A digital modem equipped with V.90 software and attached to a trunk-side T1, BRI, or PRI line. Analog modems must be equipped with V.90 software in order to connect at V.90 speeds (32–56 Kbps). Current 3Com products that can act as V.90 servers include the Total Control remote access concentrator, NETServer I-modem, MP I-modem, and Courier I-modem. The SuperStack II Remote Access System 1500 will support V.90 when it ships in July 1998.

3Com Corporation
P.O. Box 58145
5400 Bayfront Plaza
Santa Clara, CA
95052-8145
Phone: 800-NET-3Com
or 408-764-5000
Fax: 408-764-5001
World Wide Web:
http://www.3com.com

3Com ANZA
Sydney, Australia
Phone: 61 2 9937 5000
Fax: 61 2 9956 6247
Melbourne, Australia
Phone: 61 3 9866 8022
Fax: 61 3 9866 8219

3Com Asia Limited
Beijing, China
Phone: 8610 6849 2568
Fax: 8610 6849 2789
Shanghai, China
Phone: 86 21 63501581
Fax: 86 21 63501531
Hong Kong
Phone: 852 2501 1111
Fax: 852 2537 1149
India
Phone: 91 11 644 3974
Fax: 91 11 623 3192
Indonesia
Phone: 6221 572 2088
Fax: 6221 572 2089
Korea
Phone: 82 2 319 4711
Fax: 82 2 319 4710
Malaysia
Phone: 60 3 732 7910
Fax: 60 3 732 7912
Pakistan
Phone: 92 21 5846240
Fax: 92 21 5840727
Philippines
Phone: 632 892 4476
Fax: 632 811 5493
Singapore
Phone: 65 538 9368
Fax: 65 538 9369
Taiwan
Phone: 886 2 377 5850
Fax: 886 2 377 5860
Thailand
Phone: 622 231 8151 5
Fax: 622 231 8158

3Com Belgium
Belgium, Luxembourg
Phone: 32 2 725 0202
Fax: 32 2 720 1211
Netherlands
Phone: 31 30 6029700
Fax: 31 30 6029777

3Com Canada
Calgary
Phone: 403 265 3266
Fax: 403 265 3268
Montreal
Phone: 514 683 3266
Fax: 514 683 5122
Toronto
Phone: 416 498 3266
Fax: 416 498 1262
Vancouver
Phone: 604 434 3266
Fax: 604 434 3264

3Com France
Phone: 33 1 69 86 68 00
Fax: 33 1 69 07 11 54

3Com GmbH
Munich
Phone: 49 89 627 320
Fax: 49 89 627 32 233
Austria
Phone: 43 1 580 17 0
Fax: 43 1 580 17 20
Berlin
Phone: 49 30 34 98790
Fax: 49 30 34 987999
Poland
Phone: 48 22 645 1351
Fax: 48 22 645 1352
Switzerland
Phone: 41 31 996 1414
Fax: 41 31 996 1410

3Com Ireland
Phone: 353 1 820 7077
Fax: 353 1 820 7107

3Com Japan
Phone: 81 3 3345 7251
Fax: 81 3 3345 7261

3Com Latin America
U.S. Headquarters
Phone: 408-326-2093
Fax: 408-764-5730
Argentina
Phone: 541 312 3266
Fax: 541 314 3 3329
Brazil
Phone: 55 11 5181 0869
Fax: 55 11 5182 7399
Chile
Phone: 562 633 9242
Fax: 562 633 8935
Mexico
Phone: 525 520 7841
Fax: 525 520 7837

3Com Northern Latin America
Miami, Florida
Phone: 305-261-3266
Fax: 305-261-4901
Colombia
Phone: 571 629 4110
Fax: 571 629 4503
Venezuela
Phone: 582 953 8122
Fax: 582 953 9686

3Com Mediterraneo
Milano, Italy
Phone: 39 2 253011
Fax: 39 2 27304244
Rome, Italy
Phone: 39 6 5279941
Fax: 39 6 52799423
Spain
Phone: 34 1 509 69 00
Fax: 34 1 307 66 63

3Com Middle East
Phone: 971 4 349049
Fax: 971 4 349803

3Com Nordic AB
Denmark
Phone: 45 39 27 85 00
Fax: 45 39 27 08 44
Finland
Phone: 358 0 435 420 67
Fax: 358 0 455 51 66
Norway
Phone: 47 22 58 47 00
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Sweden
Phone: 46 8 632 56 00
Fax: 46 8 632 09 05

3Com Russia
Moscow
Phone: 007 095 258 09 40
Fax: 007 095 258 09 41

3Com South Africa
Phone: 27 11 807 4397
Fax: 27 11 803 7405

3Com UK Ltd.
Marlow
Phone: 44 1628 897000
Fax: 44 1628 897003
Manchester
Phone: 44 161 873 7717
Fax: 44 161 873 8053
Edinburgh
Phone: 44 131 240 2900
Fax: 44 131 240 2903

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