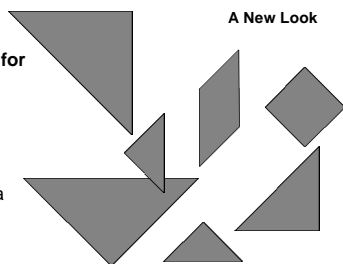


**Demand for Bandwidth:  
Preliminary Models and Results**

A New Look



**Columbia Institute for  
Tele-Information**  
Paul Rappoport,  
Temple University  
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May 3, 2001

Outline

- ◆ Objectives/Backdrop
- ◆ Motivation
- ◆ Theoretical Background
- ◆ Practical Broadband Model
- ◆ Assumptions
- ◆ Results
- ◆ Limitations, Next steps

Objectives

- ◆ Develop Estimates of Business Broadband Demand
  - Independent of Type
  - Scalable
    - ◆ Demand at Region to Demand for a Specific Business
    - ◆ Consistent with Published Data
  - Operational

Backdrop

- ◆ NTDS –Telecom Models
  - Switched Access Lines (Residential & Business)
  - Minutes (interLATA, intraLATA)
  - Features

Backdrop

- ◆ NTDS – Telecom Models
- ◆ PNR (now TNS)
  - Competitive Analysis
  - Business Services
  - Pocket Book

Backdrop: Business Models

- ◆ Survey Based
  - Expensive
  - Too Complicated
  - Limited Sample

Backdrop: Business Models

- ◆ Survey Based
- ◆ Bill Collection
  - Very Expensive
  - Limited Use
  - Not Comprehensive

Backdrop: Business Models

- ◆ Survey Based
- ◆ Bill Collection
- ◆ Void
  - Internet Activity
  - Data Services
  - Transport and Backbone
  - Special Access

Motivation

- ◆ Broadband: Fastest Growing Component of Communications

Motivation

Critical for

- ◆ Facility Investment
- ◆ ...
- ◆ Financial Analysis
- ◆ Competitive Analysis
- ◆ Network Planning
- ◆ Regulatory

Motivation

- ◆ Problems
  - Lack of Data
  - Piecemeal Approach to Broadband
    - ◆ ISDN
    - ◆ T1, Fractional T1, T3, OC12
    - ◆ DSL

Motivation

- ◆ Problems
  - Lack of Data
  - Piecemeal Approach to Broadband
  - Current Research – Limited in Scope and Applicability

Theoretical Background

- ◆ Demand for Communication Services
  - Broadband Demand (Demand for Bandwidth)
  - Theory of the firm
  - Derived Demand

Theoretical Background

- ◆ Demand for Communication Services
  - ...Derived Demand
  - Choice of Service (Based on QoS, Price, Availability)
    - ◆ ISDN
    - ◆ T1, Fractional T1, T3, OC12 ...
    - ◆ DSL

Theoretical Background

- ◆ Demand for Communication Services
  - ...Derived Demand
  - Choice of Service (based on QoS, Price, Availability)
  - Choice of Provider

Modeling Framework

- ◆ Parsimonious Specification
- ◆ Engineering – Economic Structure
  - Fixed Coefficients
  - Scope Defined by 2 Variables (Occupation & Industry)

Modeling Framework

- ◆ Parsimonious Specification
- ◆ Engineering – Economic Structure
- ◆ Available Data
  - Input – Output Table
  - CPS

Modeling Framework

- ◆ Parsimonious Specification
- ◆ Engineering – Economic Structure
- ◆ Available Data
- ◆ Simplify Objective (Bandwidth or VGE)

### Modeling Framework

- ◆ Parsimonious Specification
- ◆ Engineering – Economic Structure
- ◆ Available Data
- ◆ Simplify Objective
- ◆ Parameters – Based on Expert Opinion, Experience, Other Studies

### Practical Broadband Model

- ◆ Practical Approach
  - Data Proprietary
    - ◆ Confidential
    - ◆ Not Available

### Practical Broadband Model

- ◆ Practical Approach
  - Data Proprietary
  - Limited Availability
    - ◆ Partial View of the Market

### Practical Broadband Model

- ◆ Practical Approach Because:
  - Data Proprietary
  - Limited Availability
  - Definition Issues
    - ◆ What is Broadband?
    - ◆ Price?

### Practical Model: Assumptions

- ◆ Communications Demand
  - Varies by Industry
  - Varies by the Occupational Distribution within an Industry

### Practical Model: Assumptions

- ◆ Communications Demand
- ◆ Broadband Factors Can Be Created
  - Occupational Intensity
  - Industry Intensity

Practical Model: Assumptions

- ◆ Communications Demand
- ◆ Broadband Factors Created
- ◆ Normalization via Macro Benchmarks
- ◆ Broadband Services are Fungible

Practical Model: Assumptions

- ◆ Communications Demand
- ◆ Broadband Factors Created
- ◆ Normalization ... Broadband
- ◆ (For now) Broadband Services are Fungible

Practical Model: Assumptions

- ◆ Communications Demand
- ◆ Broadband Factors Created
- ◆ Normalization ... Broadband
- ◆ (For now) ... Fungible
- ◆ Separate Business Access From Other VGE

Metrics

- ◆ Bandwidth Intensity by Occupation i for Industry j
- ◆ Telephone Intensity for Occupation i and Industry j

- ◆ Industry Intensity of Communication Services
- ◆ Bandwidth Intensity on per Employee Basis for Industry j

Computation

$$\sum_i a_i b_{ij} = b_j \quad \text{Bandwidth Intensity for Industry } j$$

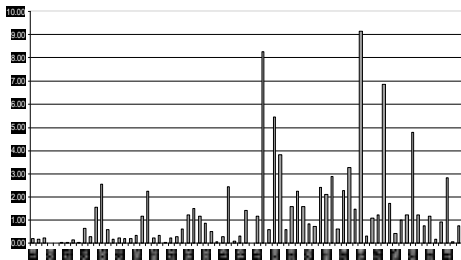
$$\frac{b_j}{\sum_j w_j b_j} = e_j \quad \text{Relative Bandwidth Intensity for Industry } j \text{ Relative to Average Bandwidth Intensity (Weights Given by } w)$$

Set Value of KB/Employee for  $e_j = 1$   
 Derive for Bandwidth (VGE) and for Switched Access

Occupations

Exec, Admin, Managerial	1	7	Precision production, craft, and repair
Professional	2	8	Machine operators, assemblers, and inspectors
Technicians	3	9	Transportation and material moving equipment
Sales	4	10	Handlers, equip cleaners, helpers, and laborers
Admin support including clerical	5	11	Farming, forestry, and fishing
Protective service	6	12	Other Service

### Communications Intensity



Source: BLS I- O Table

### Normalization

- ◆ Information on Broadband Available from BPI Telcodata's **CALMS** Database (Competitive Access Line Market Sizing) Tool [www.telcodata.net](http://www.telcodata.net)

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- ◆ Information on Broadband Available from BPI Telcodata's **CALMS** Database (Competitive Access Line Market Sizing) Tool [www.telcodata.net](http://www.telcodata.net)
- ◆ Information on Data (VGE) Lines and Special Lines **for All Wire Centers**
- ◆ Business Access Lines **for All Wire Centers, Counties, MSAs**

### Example

Weight	IND1	IND2	
OC1%	.30	.20	
Band1	7	10	
OC2%	.40	.40	
Band2	5	5	
OC3%	.30	.40	
Band3	2	1	
ΣBand*	4.7	4.4	4.49
OC%	1.046	0.98	1

- Weight describes the industry use of communications
- Last row provides normalized value
- Assign 75kb/E to norm; then IND1 has 78.5kb/E and IND2 has 73.5kb/E

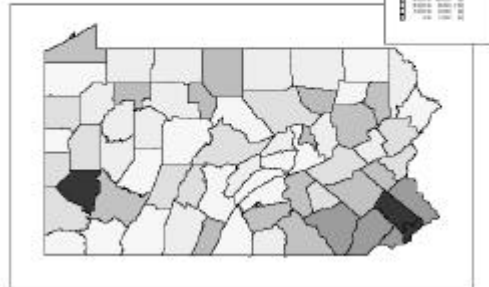
### Interpretation of Business Broadband Estimates

- ◆ CALMS includes
  - PRI-ISDN
  - ADSL
  - Frame
  - DS1, DS3
  - Private line
  - Special Access End User
  - Transport
    - ◆ ISP to Long Haul Backbone
    - ◆ CO to IXC POP
    - ◆ Ring Consolidations

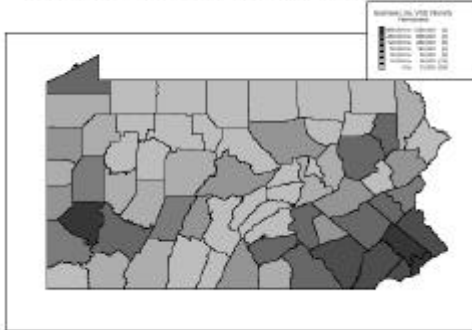
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    - ◆ Ring Consolidations
- ◆ "Broadband" Model
  - PRI-ISDN
  - ADSL
  - Frame
  - DS1, DS3
  - Private line
  - Special Access End User
  - Non-ILEC ADSL
  - Cable Modem
  - CLEC End User Facilities

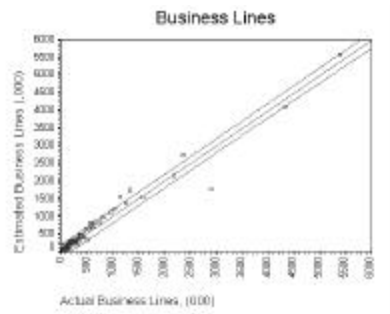
Pennsylvania Digital VGE Prediction by County



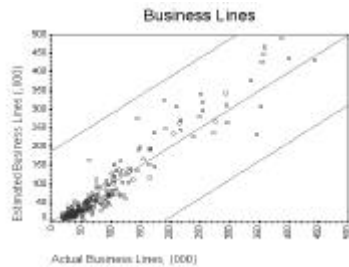
Pennsylvania Business Lines, Digital VGE Intensity by County



## Business Lines



## Business Lines (Areas <500,000)



## Prediction

	Estimated VGE	Actual VGE
Philadelphia	2,472,661	2,596,395
Los Angeles	6,572,695	6,748,344

Source: CALMS

- Limitations, Issues & Questions
- ◆ Appropriateness of National O-I Matrix
    - Stability of Occupational Distributions
    - Stability of Bandwidth and Business Line Intensity Factors

- Limitations, Issues & Questions
- ◆ Appropriateness of National O-I Matrix
  - ◆ Adjustments
    - Use Survey Data to Construct Regional and Local Matrices
    - Updates to Intensity Measures

- Limitations, Issues & Questions
- ◆ Appropriateness of National O-I Matrix
  - ◆ Adjustments
  - ◆ Derivation of Normalization Factor
    - Use of Aggregate Public Data
    - Use of Survey Data
    - Use of Expert Opinion

- Limitations, Issues & Questions
- ◆ Appropriateness of National O-I Matrix
  - ◆ Adjustments
  - ◆ Derivation of Normalization Factor
  - ◆ Adjustments to Normalization

- Limitations, Issues & Questions
- ◆ Appropriateness of National O-I Matrix
  - ◆ Adjustments
  - ◆ Derivation of Normalization Factor
  - ◆ Adjustments to Normalization
  - ◆ Update Procedure
  - ◆ Validation

- Validation
- ◆ Compare Prediction to Customer Demand
    - Currently Analyzing 5000 Businesses
    - Assess Prediction of:
      - ◆ Business Lines
      - ◆ VGE (Data, Specials)

Next Steps

- ◆ Incorporating Internet Activity
  - Traffic Information
  - Business to Business Activity
  - [www.plurimus.com](http://www.plurimus.com)

Next Steps

- ◆ Incorporating Internet Activity
- ◆ Testing Models (with ILECS)
  - Business Lines
  - VGE

Next Steps

- ◆ Incorporating Internet Activity
- ◆ Testing Models (with ILECS)
- ◆ Delphi Review

For more information

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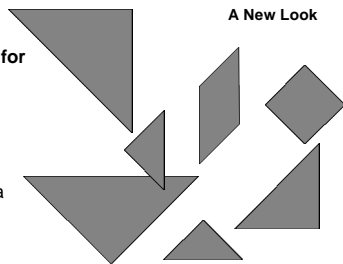
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For additional information and upcoming CITI events  
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<http://www.citi.columbia.edu/>

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