Engineering Network Access Solutions

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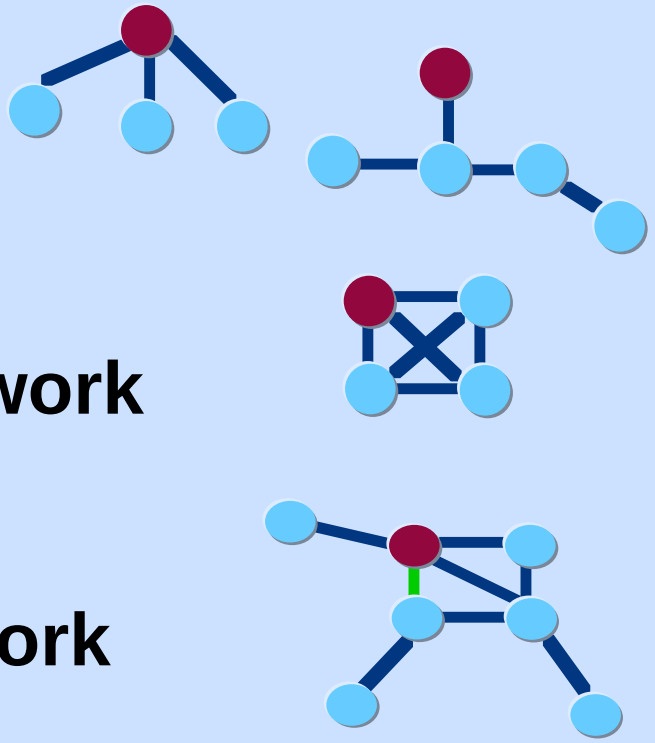
Agenda

- **Network boundary overview**
- **Network tier sites and cost identification**
- **Network tier requirements analysis**
- **Network boundary optimization**
- **Case Study**
- **Summary**

Network Boundary Overview

- **Network topologies**
  - **star networks**
  - **hierarchical or tree networks**
  - **meshed (flat) networks**
  - **hybrid networks**
- **Backbone or transport network**
- **Access network**
- **Remote branch or tail network**



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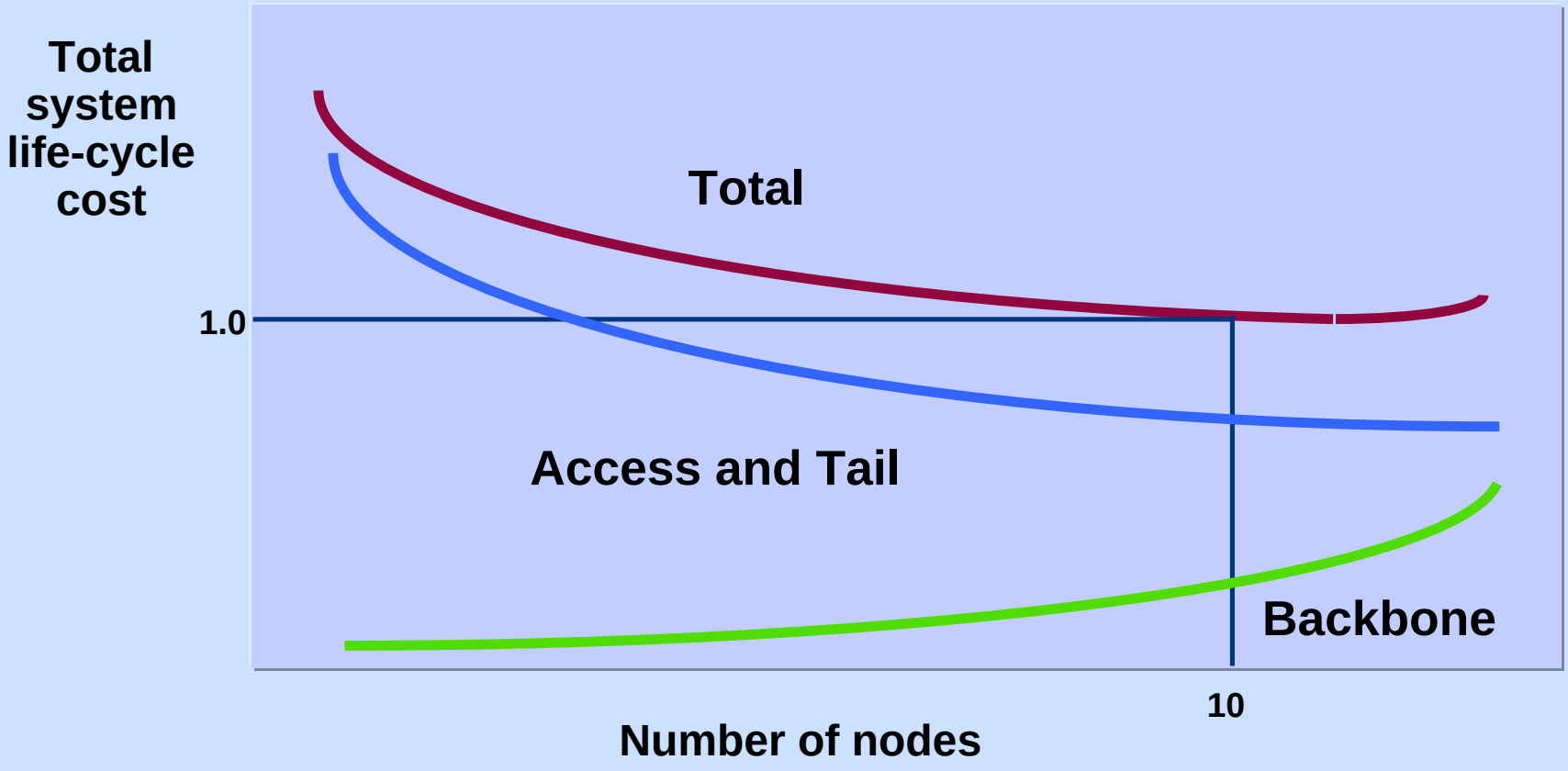
Identifying Sites for Each Tier

- **Backbone locations**
  - **locations with high availability and serviceability**
  - **high location accessibility for maintenance**
  - **locations' place in the organizational hierarchy**
- **Concentrator or access locations**
  - **access bandwidth hardware capacity availability**
  - **access network service cost**
  - **traffic characteristics or flow**
- **Remote or tail user locations**

Network Cost in Relation to Tiers

- **Total network life-cycle cost includes:**
  - **design and analysis**
  - **recurring and non-recurring charges for hardware and carrier services**
  - **operation and maintenance**
- **Recommended tier networking cost**
  - **Backbone cost should be limited to 30% (20% is ideal)**
  - **Access cost should be limited to 40%**
  - **Tail cost should be limited to 30%**

Network Cost in Relation to Tiers



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Requirements Analysis

- **User requirements**
  - **traffic characteristics**
  - **connectivity and protocol**
  - **performance (delay, availability and data accuracy)**
- **Network requirements**
  - **expandability, scalability and evolution**
- **Value-added services**
  - **network management, billing, security and etc.**
- **Non-technical requirements**
  - **budget constraints, politics and etc.**

Performance Allocation

- **Availability**
  - **Backbone - 99.99% or better with 2 hours of RTF**
  - **Access - 99.9% or less with 4 to 8 hours RTF**
  - **Tail - 99% or less**
- **Response time**
  - **Backbone - less than 20% of total Delay**
  - **Access - 50% of the total delay due to adaptation process**
  - **Tail - remaining time after backbone access**
- **Minimum error and data accuracy**
  - **Backbone: $1x10^{-8}$ or better over 5 minute period**
  - **Access and Tail : $1x10^{-6}$ or better over 5 minute period**

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Network Tier Optimization

- **Backbone**
  - **use vendor-specific tools like X-Cel and NetCalc for Magellan to analyze network performance and routing**
  - **use design tools like MIND-DATA/PC or others that optimize the network topology based on traffic patterns, circuit tariff and performance parameters**
  - **minimize the remote branch concentration at the backbone node**
  - **size baseline design hardware for modular growth**
  - **Ensure that all backbone trunk speed and basic switch hardware configurations are similar**

Network Tier Optimization

- **Access locations**
  - **determine bandwidth requirement from the traffic analysis results**
  - **determine the excess bandwidth and equipment capacity**
  - **check for any special requirements**
  - **find cheapest access connectivity to backbone for all access sites**
  - **determine total access network service cost and check with budget**
  - **find cost to increase access capacity to next level**
  - **monitor the traffic patterns and monthly recurring charges**
  - **re-optimize the access service when any changes in tail tier**
  - **re-evaluate total network topology for any major user change**
  - **mark locations with access capacity to support the tail sites**

Network Tier Optimization

- **Remote locations**
  - **determine bandwidth requirement from the traffic analysis results**
  - **check for any special requirements**
  - **find the cheapest connectivity to access or backbone network**
  - **avoid increasing the number of circuits to access network**
  - **determine the total tail network cost and check with budget**
  - **monitor the traffic patterns and monthly recurring charges**
  - **tail tier will be effected when backbone and/or access change**
  - **re-evaluate all three tiers if requirements change**

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Case Study - Locations

- **High-level customer locations**
  - **1 headquarters (HQ)**
  - **1 data computing center (DCC)**
  - **1 training center (TC)**
  - **8 regional offices (RO)**
  - **15 district offices (DO) with 5 planned in year 3**
  - **50 field offices (FO) and 5 more planned in years 2,3, and 4**
- **Network life-cycle is 5 years**
  - **network design and costs for years 1,3 and 5**
  - **capacity must be planned for each year**

Location Classification for Tiers

- **Backbone**
  - 8 regional offices
  - 1 headquarters
  - 1 DCC without any remote location concentration
- **Concentrator location**
  - 20 district offices
  - 1 training center
- **Remote or tail locations**
  - 60 field offices

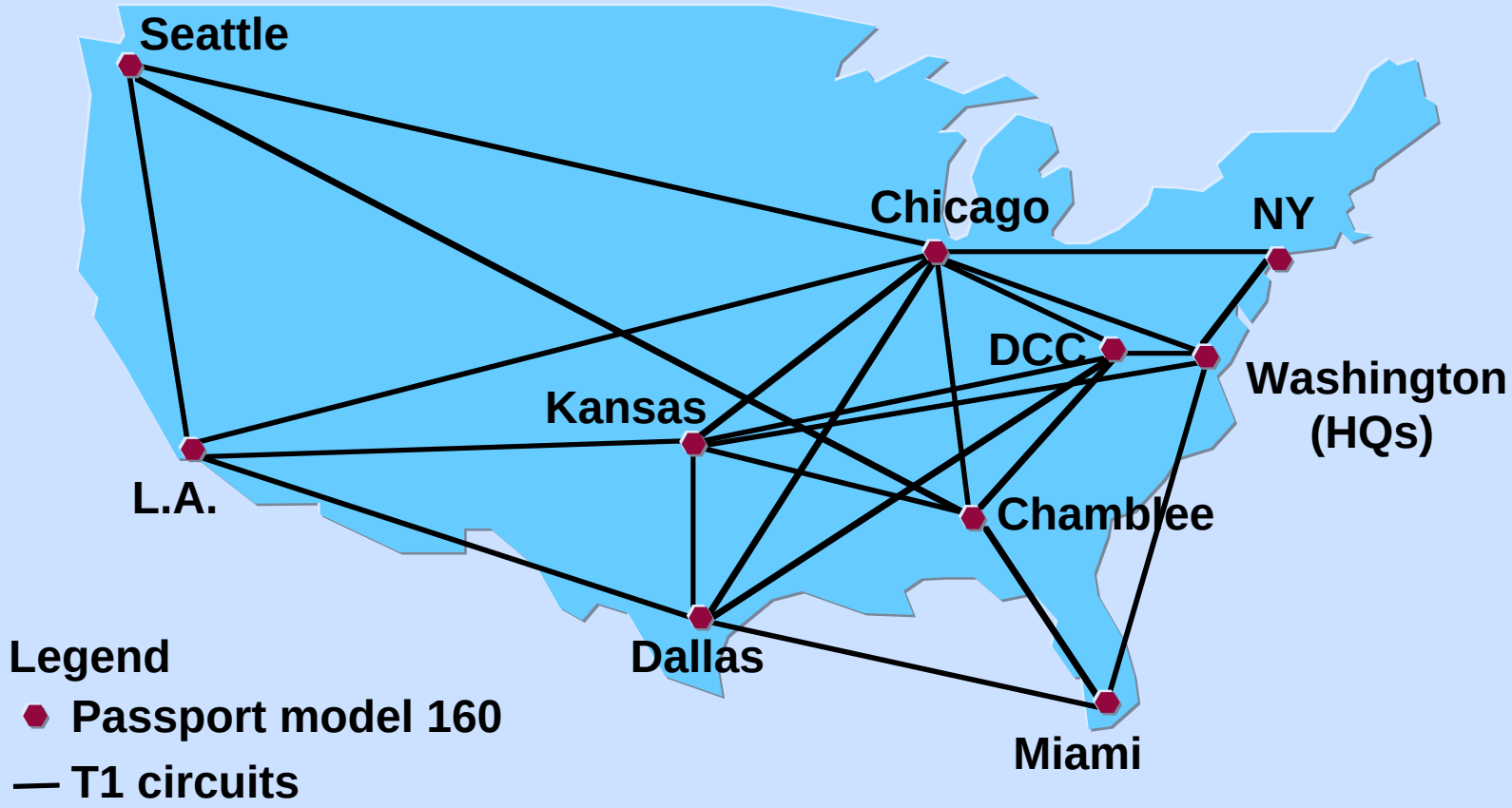
Network Life-cycle Budget

- Network planned budget for 5-year is $42M
- Goal is to save $5M over network life
- Current backbone annual cost is $3.3M
- Current access and tail network annual cost is $5.1M
- Current network provides services to both data and voice applications using a TDM based bandwidth manager
- Very limited video conferencing between regional offices and headquarters
  - support via switch digital lines
  - annual cost is not included in the network budget

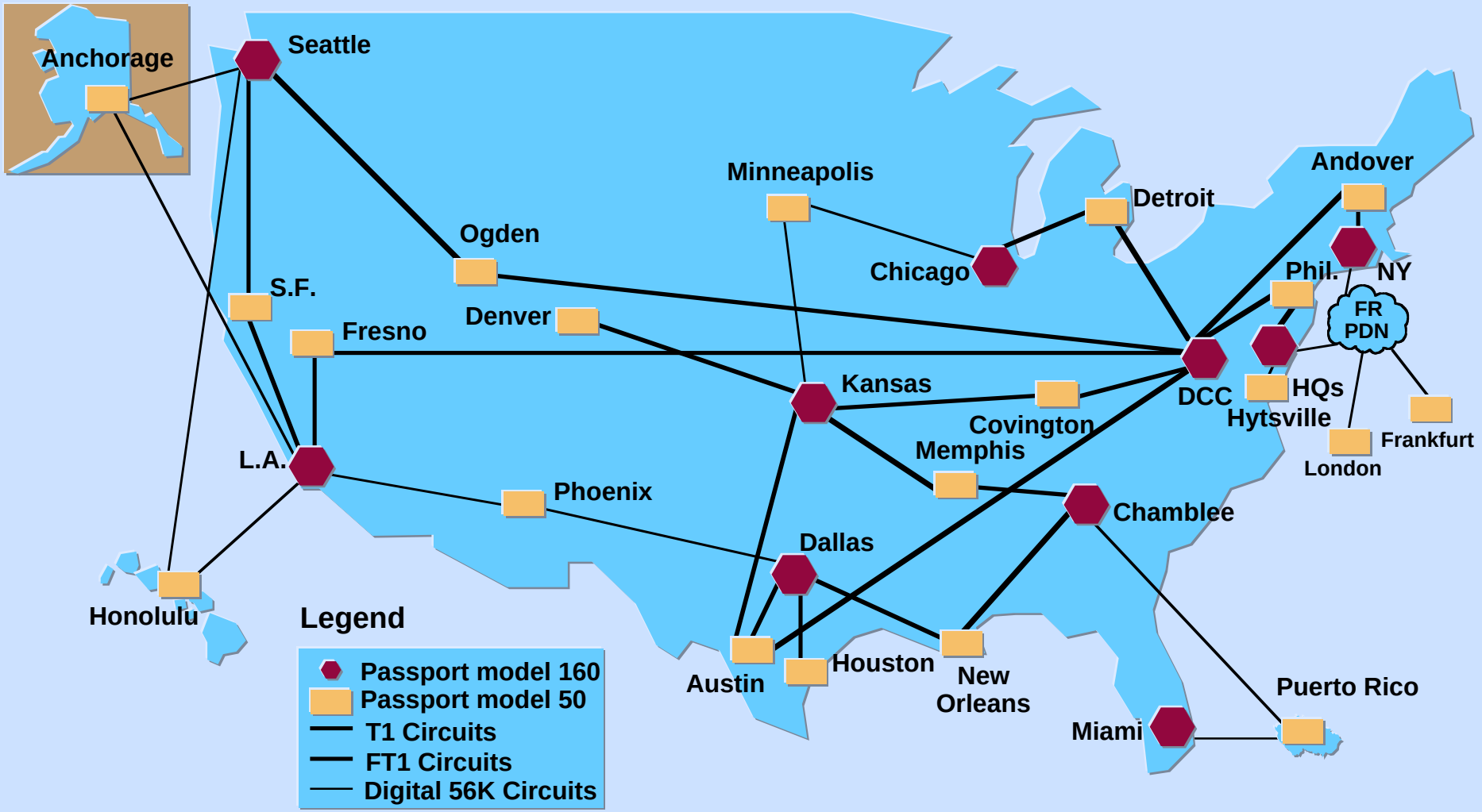
Performance Requirements

- **Availability**
  - **99.99% regional offices, HQ and data computing center**
  - **99.9% district offices**
  - **99% field offices**
- **Delay**
  - **end-to-end busy hour or worse case delay**
    - **64 byte Packet - 150 milliseconds**
    - **1024 byte Packet - 1 second**
- **Data accuracy**
  - **$1x10^{--7}$ for end-to-end transmission over 5 minute period**

Backbone Tier



Access Tier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Ogden
Chicago
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NY
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Denver
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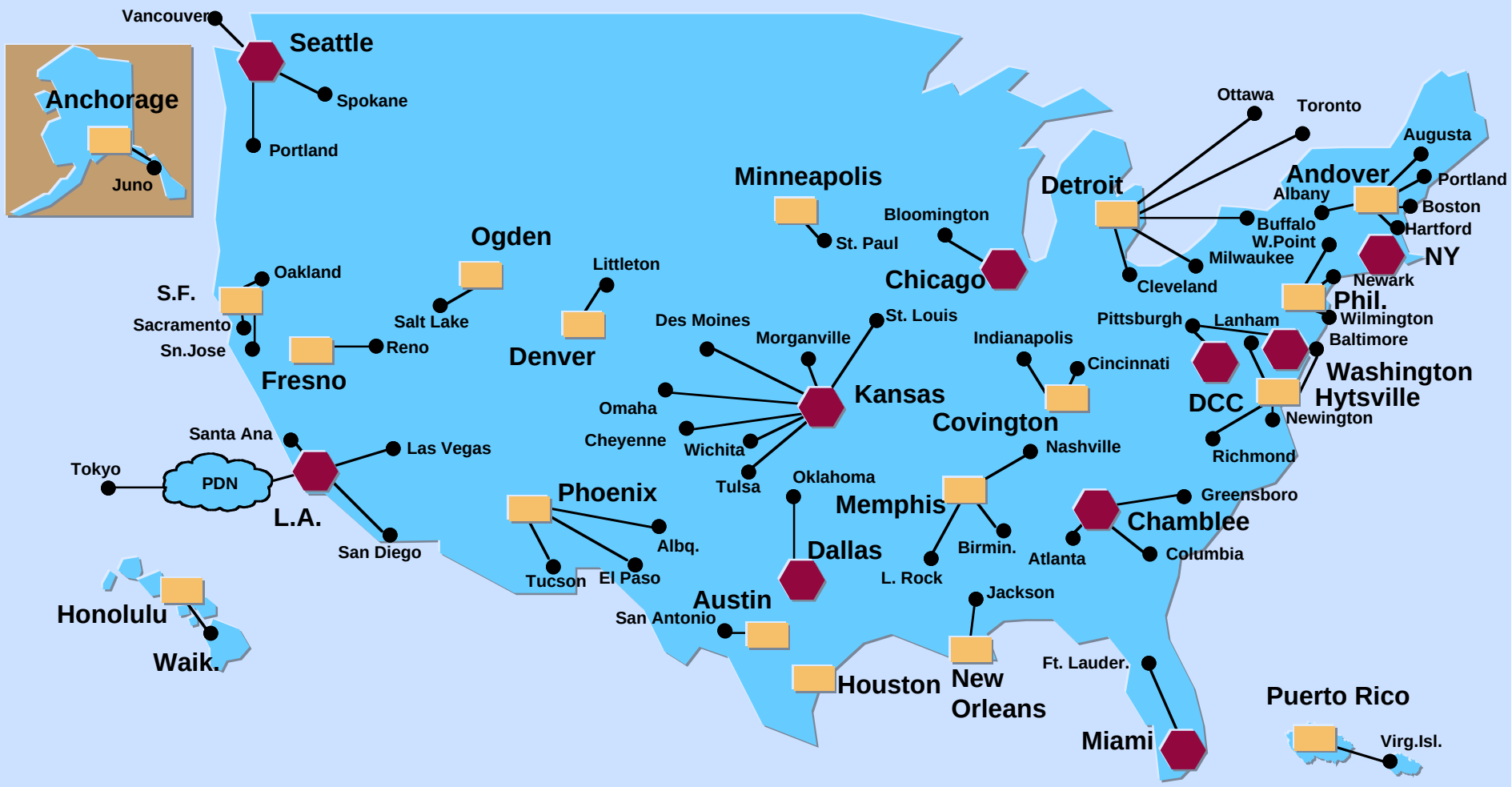
PDN
Fresno
Kansas
DCC
HQs
Hytsville
Covington
Memphis
Frankfurt
London
L.A.
Phoenix
Chamblee
Dallas
Honolulu
Legend
Passport model 160
Passport model 50
T1 Circuits
FT1 Circuits
Digital 56K Circuits
Austin
Houston
New
Orleans
Miami
Puerto Rico

Tail Tier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W.Point
NY
Milwaukee
Newark
Cleveland
Phil.
Wilmington
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Pittsburgh
Lanham
Washington
Hytsville
Newington
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Reno
Fresno
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Jackson
Houston
New
Orleans
Ft. Lauder.
Miami
Honolulu
Waik.
Puerto Rico
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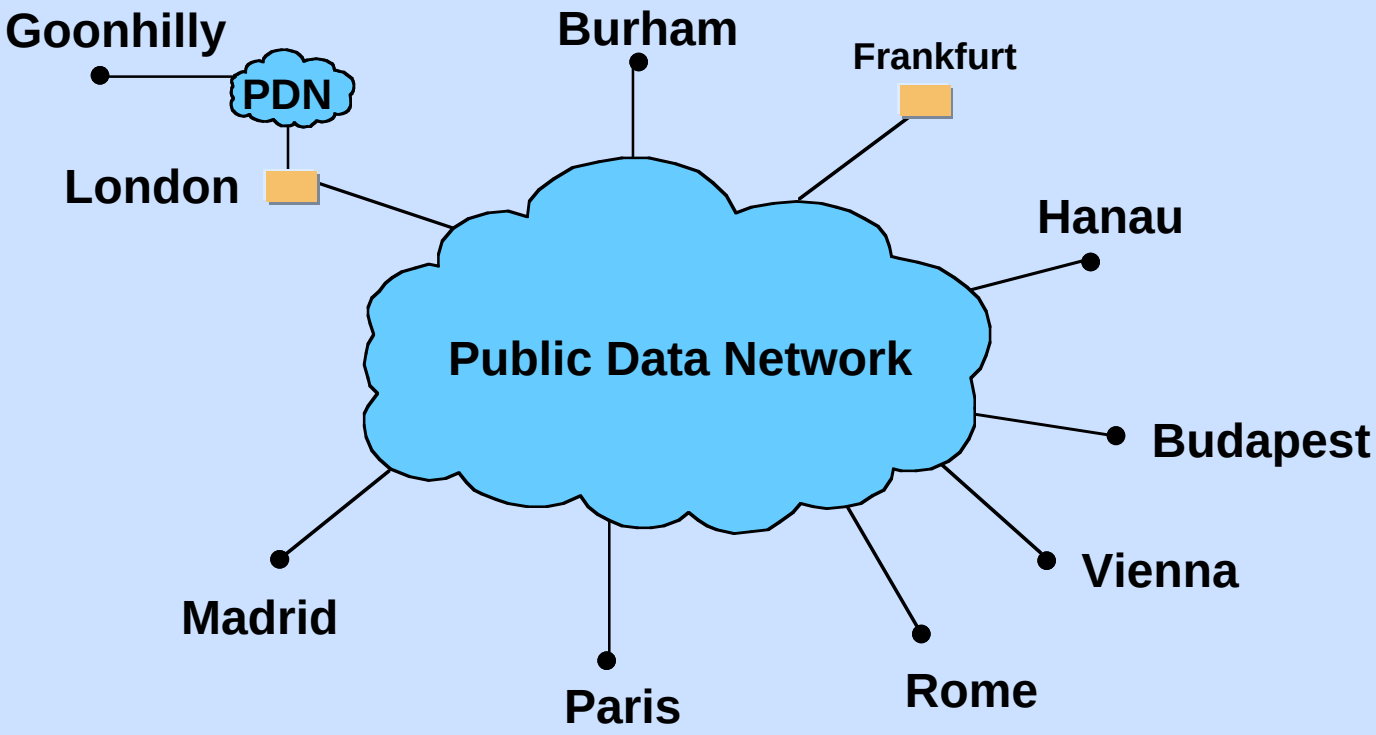
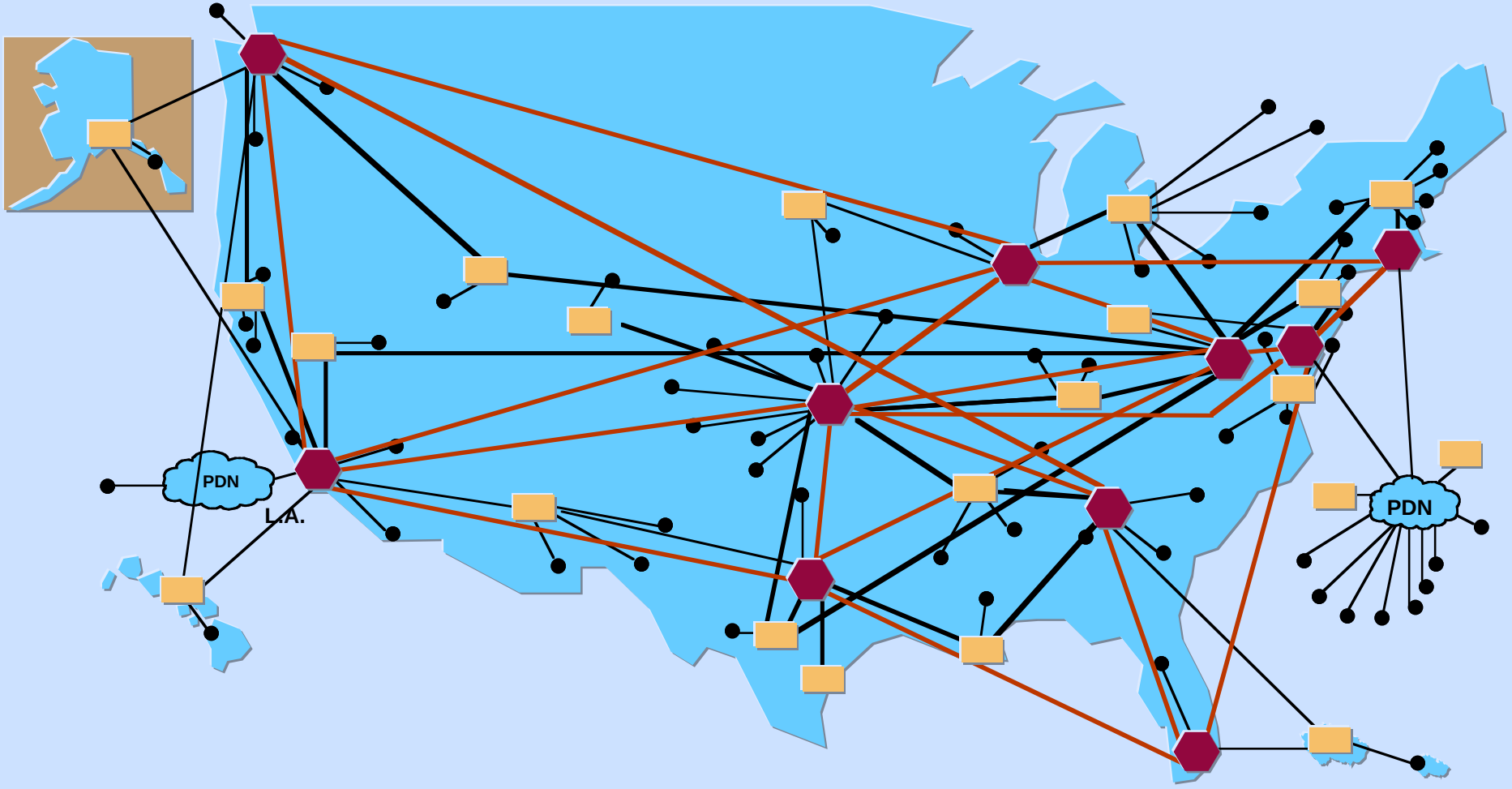
Tail Tier - Europe



Case Study - Network Connectivity



Case Study - Tier Cost and Performance

- **Network life-cycle cost $35.5M**
  - **Backbone $9.1M**
  - **Access $14.1M**
  - **Tail $12.3M**
- **Network Life-cycle saving is $6.5M**
- **Performance**
  - **delay is 10% better than required**
  - **availability requirement is exceeded**
  - **data accuracy $1x10^{-8}$ or better**
- **Magellan Passport achieved and exceeded design goals for the case study**

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Summary

- **Network partitioning provides an open architecture such that each subnet could be enhanced, independently**
- **Selecting appropriate carrier services, switches like Passport model 50 and model 160 would reduce the network life-cycle cost and provide the transport services**
- **Access and tail lines cost is the largest and the most topology sensitive**
- **The cost of network equipment is technology-sensitive and decreasing everyday**
- **Network design and optimization is more of an art than a mathematical solution**

Additional References

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