TEKMARK
GLOBAL SOLUTIONS LLC

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Ultra Low-Latency (ULL) Design and Management Requirements for The Data Center

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Agenda

1. Who we are
2. What we are going to talk about
   - Sample of key ULL technologies
   - ULL DC/Network Requirements
   - Linux in ULL Environments
3. IT departments need to work closely to achieve ULL
4. Sample of key ULL technologies
5. Measuring ULL Environments
6. Traditional DC/Network Requirements
7. ULL DC/Network Requirements
8. Linux in ULL
9. Business Challenges
10. Key Take Away

Tekmark Global Solutions – Who We Are

- ***Established***
  - A global company with 18 domestic and international locations, founded in 1979.
  - One of the largest privately held IT professional services and solutions firms in the U.S., with annual revenues of over $150M
- ***Experienced***
  - Over 1,200 top quality enterprise engineers and project managers.
  - Clients include 45 Fortune 100 companies, as well as numerous small to mid-size clients.
- ***Professional***
  - Specialists in designing, building and managing IT, telephony, and network solutions.
  - Solutions and software development outsourcing.

Ultra Low-Latency (ULL) Design Requirements

Ultra Low-latency (ULL) Design Requirements encompass a broad range of technology specialties. In this presentation we will highlight a number of those key technology specialties but given the allotted time we will focus on two topics:

- ULL Data Center/Network Requirements
- Linux in ULL Environments

IT departments must work more closely to achieve ULL

- The traditional approach of delivering well designed component parts no longer works in a ULL environment.
- In order to design the lowest latency every link in the transaction life-cycle must be designed, developed, integrated, and measured as one holistic solution :
  - Wide Area Network
  - Local Area Network
  - Market Data – Direct Market Access
  - Application development
  - Order Management Systems (OMS)
  - Execution Management Systems (EMS)
  - Algorithm Designers
  - Database Design
  - Data Center operations

Sample of next generation Solutions for ULL Architecture

- Switching Architecture that supports Low Latency Designs
  - Spine-Leaf
  - TRILL (Transparent Interconnect of Lots of Links)
- High Bandwidth Links
  - 10GB/40GB/100GB
    - Ethernet or InfiniBand
- Application Adapters that Support ULL for Storage and Processing
  - Fusion I/O
  - GPU (Fermi)
  - RoCE / iWarp / RDMA
  - Myricom
- Low Latency OS that support open standards
  - Linux

Sample of next generation Solutions for ULL Architecture con't

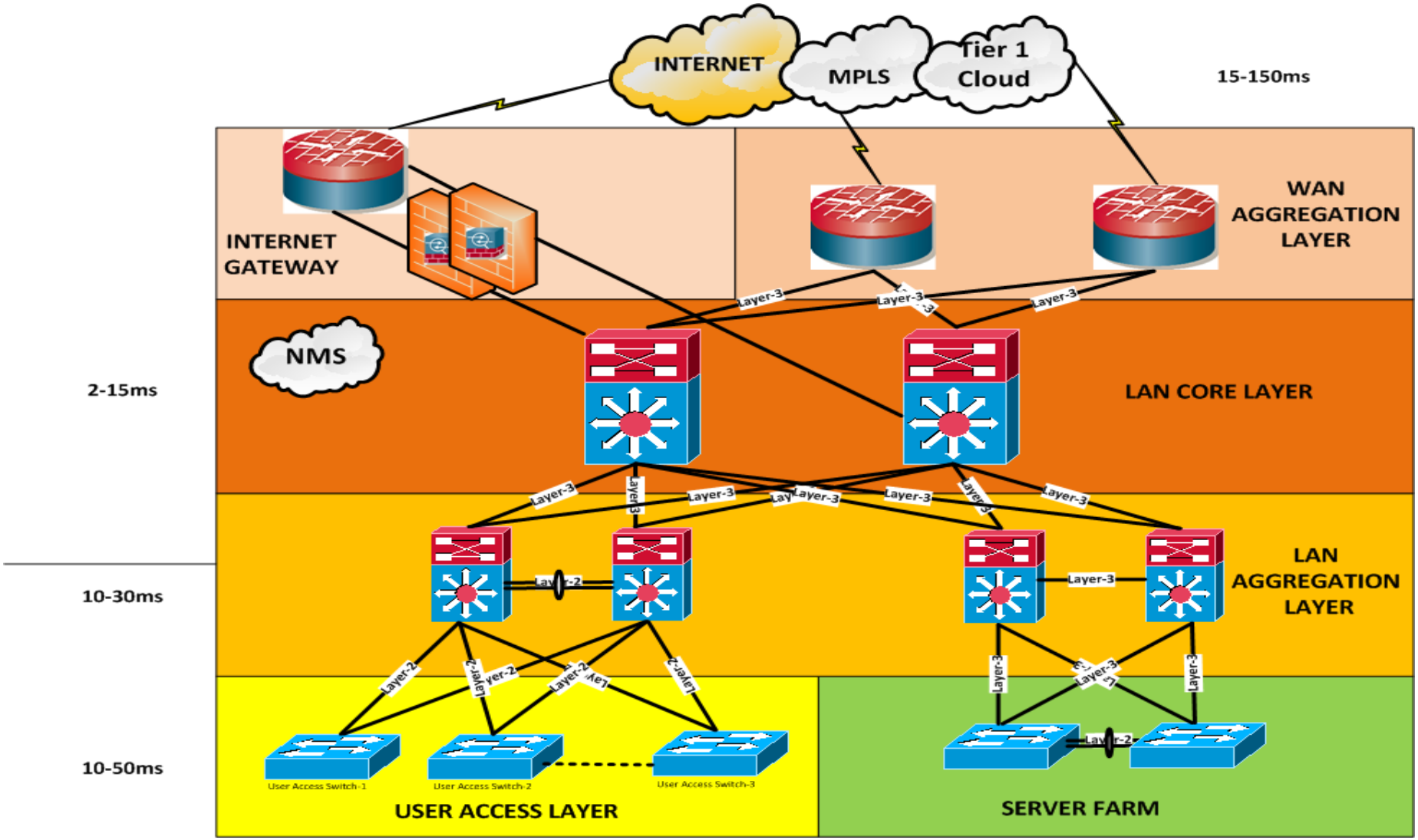
- Specialized Database providers
  - KX Systems
  - StreamBase
- New application design requirements and technologies
  - Complex Event Processing / Stream processing
  - Caching
  - Direct memory access (DMA) / Kernal Bypass
- Specialized Carriers
  - Market Data Providers
  - Proximity Providers
  - Co-Location Providers
- Messaging Vendors
  - IBM/MQ , 29 West / Informatica, Tibco, Etc.

Managing and Measuring ULL Environments

Things to Consider for ULL Measurements:

- How to provide nanosecond measurement resolution.
- What is the clock source reference?
- What should be measured?
- How to measure without impacting performance?
- What is the timeliness of measurement reporting i.e. real-time?

Traditional Data Center / Enterprise Infrastructure



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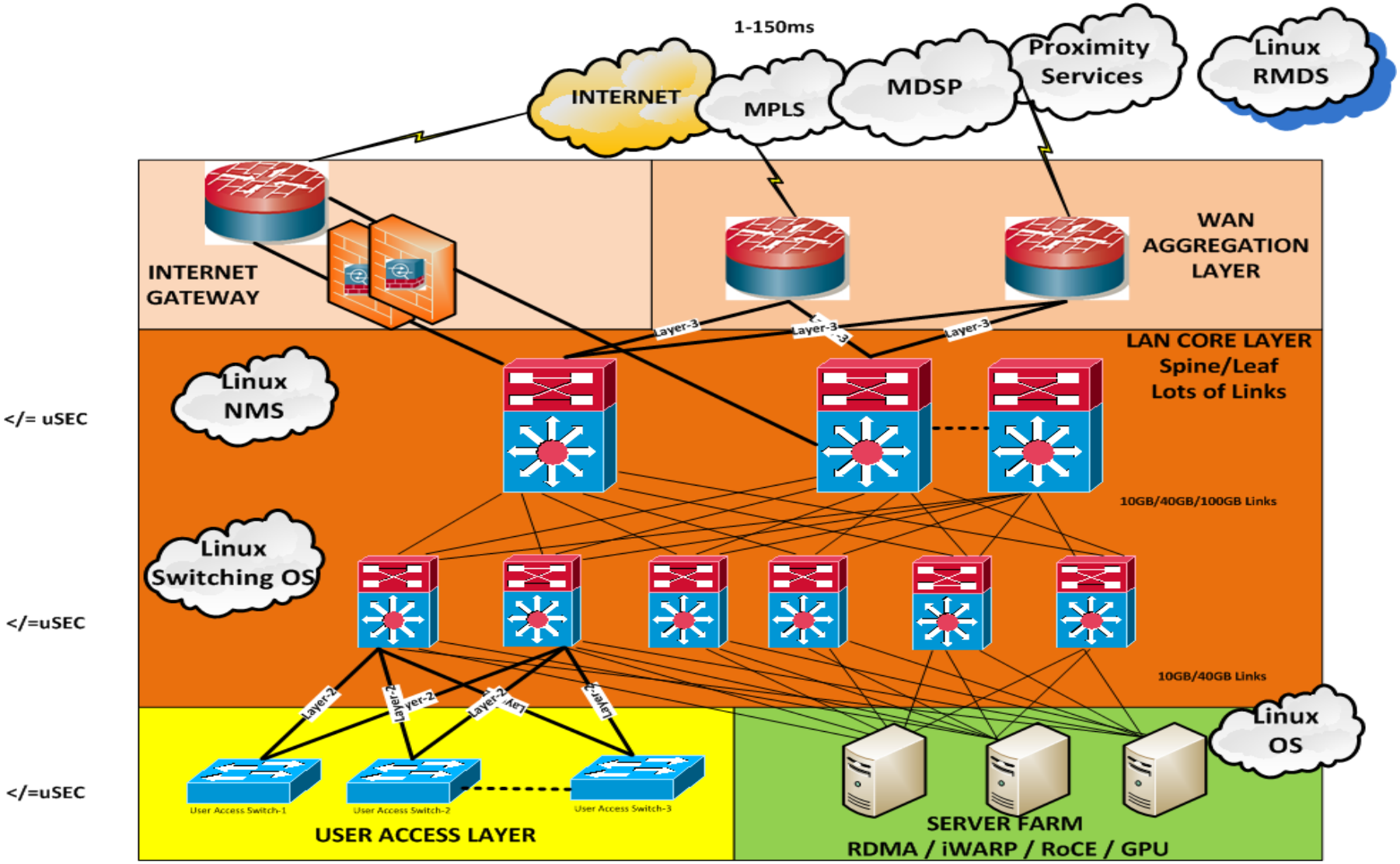
Simplified Typical ULL DC/Network Architecture



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Traditional Requirements

- Bandwidth requirements grow
  - Traditional carriers support this need
- Shared Architecture
  - BU's can support applications across common storage, OS, and Infrastructure
- Major Upgrades happen every 2-5 years
- Hop times are measured in milliseconds (ms) and even at high latency 150ms-200ms email still flows, applications still run
- Traditional 3 Tier Architecture
- HOP count is not as important in traditional design

ULL Requirements

- Bandwidth Requirements grow
  - Latency must be absolute minimum requiring specialized carriers must be engaged or point-to-point dark fiber deployed
- Protected Infrastructure
  - Networks have to be measured and configured outside of legacy enterprise architecture to support ULL
- Must be adaptable to change
  - New products shaving uSec can spark entire architecture changes in months
- Hop times must be measured in sub milliseconds
- Flat Network / Crossbar Network Design
- Minimized HOP Count (<2 Hop)

Why Linux?

- Fastest Kernel
- Majority of ULL Devices are built on a Linux environment
- Community support for ULL applications
- Easy to “tweak” things to provide a higher level of performance
- Many high performance vendor solutions have imbedded Linux

High Level Business Challenges and Questions

- How will you convince Management that you need new network devices every 3-6 months?
- How will you gain support from global enterprise group to allow your trading team to have a dedicated infrastructure
- How will you justify higher cost of network engineers that typically support this kind of architecture? (usually 2x-3x)
- How will you keep up with all of this change in a large enterprise?
- How will you manage these environments at ULL speeds?
- Many of the vendors in this space are artesian vendors very few well known companies produce product that primarily focuses on ULL technologies.
- How can I convince management to invest in optimized Linux environments?

Key Take Away

- Utilize vendors and partners that have a specialty in ULL solutions
- Perform Quarterly Assessments of BOTH the network and application stack.
- This stuff is complex make sure you stay ahead of the curve
- Keep Management involved with key learning's and market technology changes as best you can
- Build systems as Direct Access Everything! Nothing shared in this kind of architecture will support your ULL needs
- ULL Designs are not just one area but a comprehensive approach towards optimization
- Linux offers the best and most available OS for ULL environments!

Thank You!

Questions?