Applications of PTP in non-Telecom networks

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November 1st -3rd 2011, ITSF 2011

Introduction

PTP/ 1588 has grown from its initial objective of

- Synchronization of real-time clocks in components of a networked distributed measurement & control system
- Intended for relatively localized systems typical of industrial automation and test and measurement environments.
- Applicable to local area networks supporting multicast communications (including but not limited to Ethernet)

Earliest applications outside the “LAN” applications

- Telecom networks
  - Backhaul applications
- Audio Video networks

Introduction Cont.

The Synchronization/ Time Transfer has applications in

- Smart grid
  - Power generation
  - Transmission & distribution
  - Advance metering Infrastructure
- Data center applications, Financial sector
- Cloud computing
- Security/ forensics
- Intelligent transportation systems

Agenda Cont.

- Examine the network topologies in above applications
  - Compare them to the telecom networks
- Estimate the precision of synchronization needed
  - Attempt to derive/ look at published numbers
- The constraints on these networks
  - Suggest possible solutions

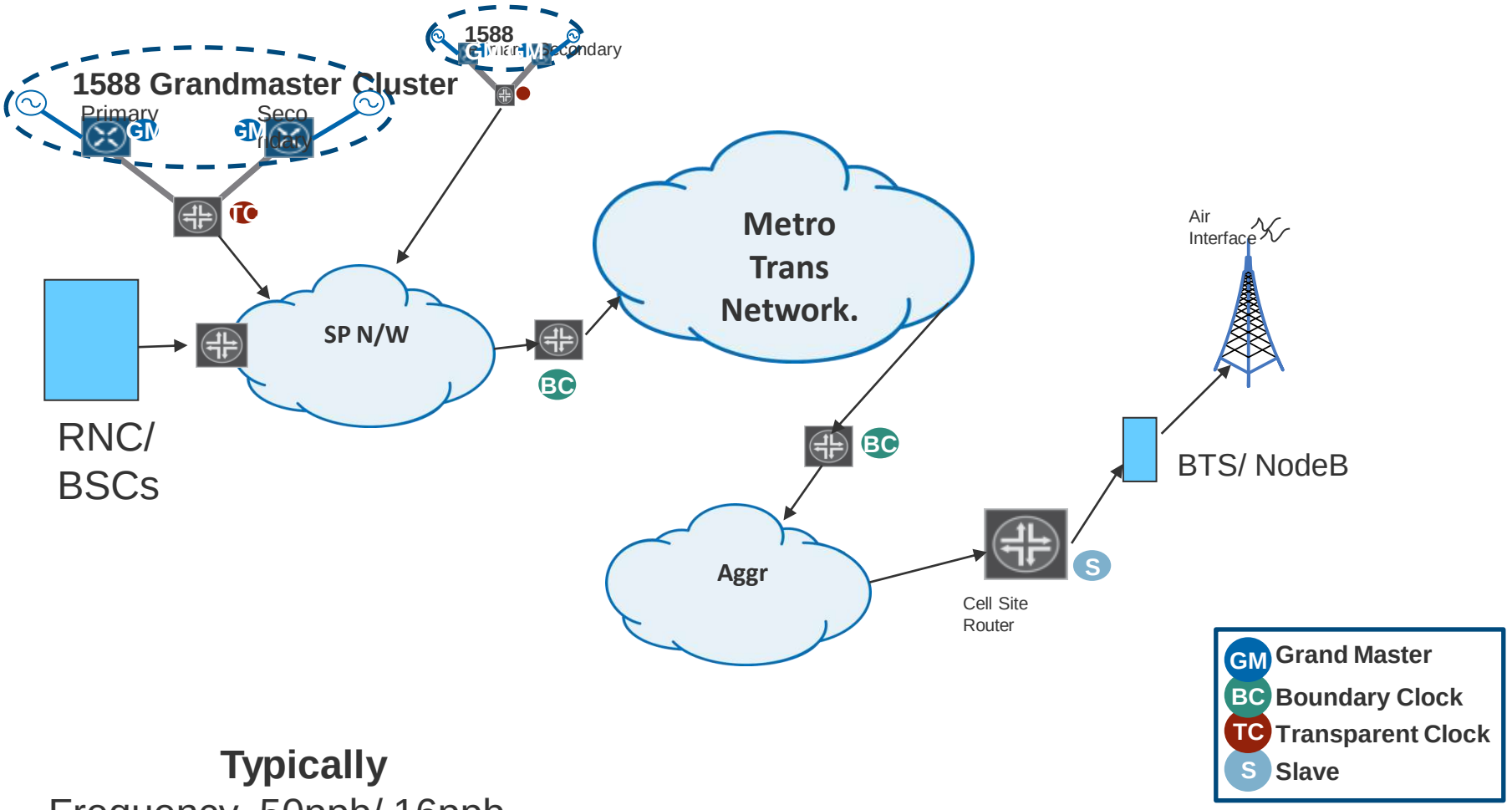
"Or ask the audience….."

A SMALL DEVIATION

CRITICAL INFRASTRUCTURE SECTORS

http://www.dhs.gov/files/programs/gc_1189168948944.shtm

Telecom (Backhaul Network)



Typically

Frequency 50ppb/ 16ppb

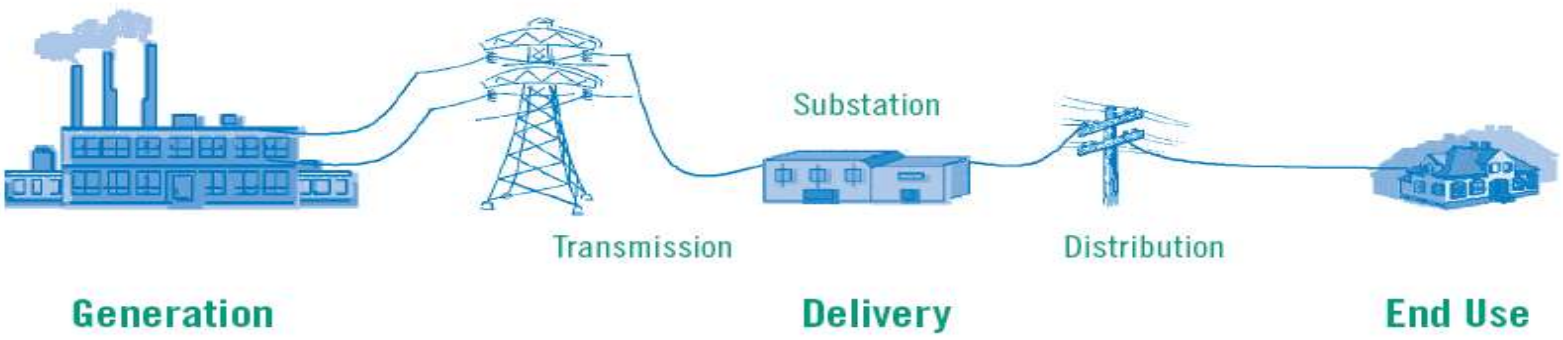
Phase/ Time 1uS

Smart Grid

Smart Grid Overview

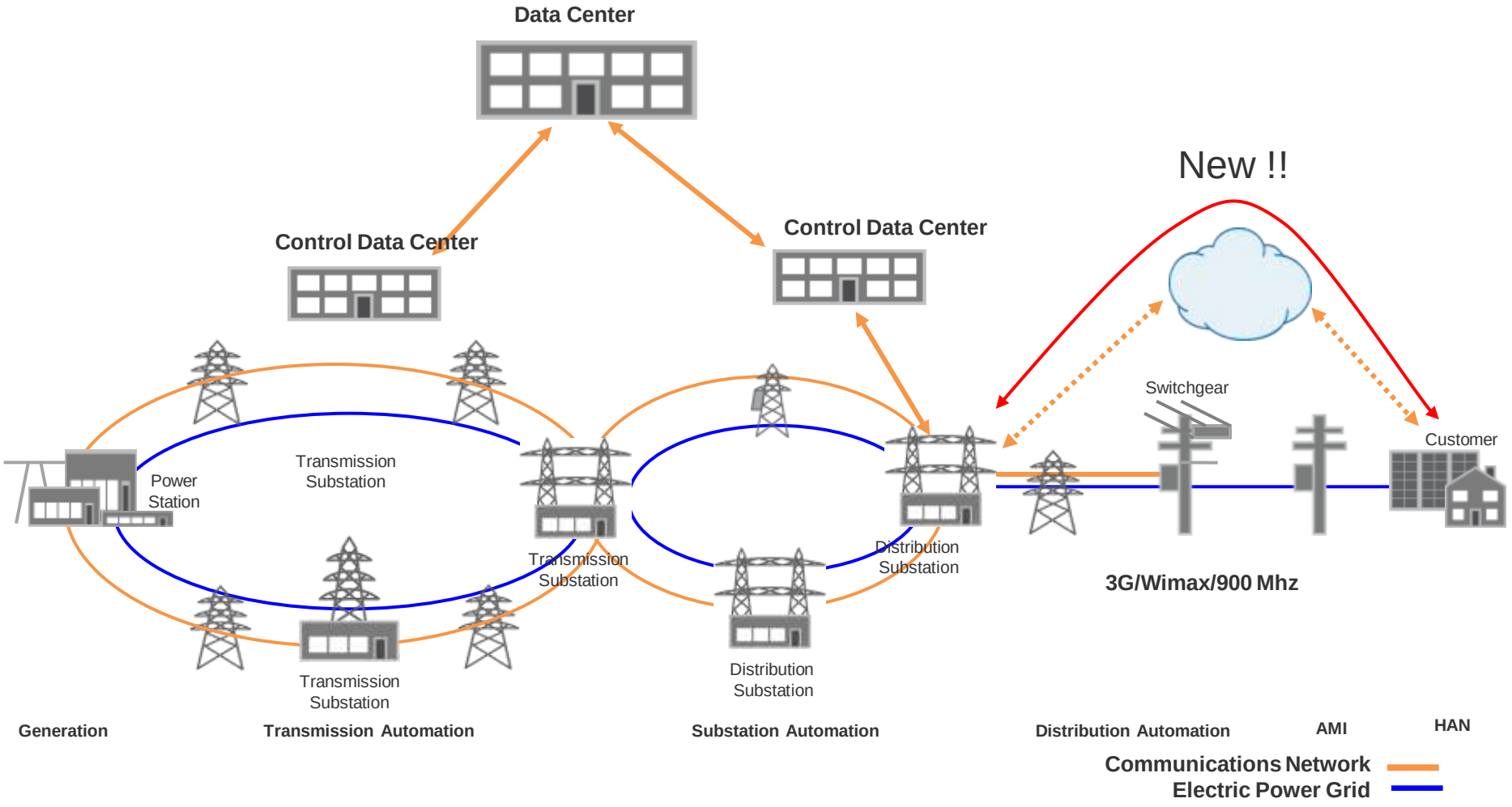
The power network essentially consists of

- The power generation
- Transmission
- Distribution
- Consumers/End users



Smart Grid

Power & Communication N/W



Smart Grid

Power Generation

Power generation

- Logging applications
- Industrial (power) control systems
- Synchronizing Generation to Transmission

- At 60 Hz
  - 1 degree = 46.3 uS
- Precision for these applications
  - Logging typical 1mS
  - Sync Gen. to Transmission (1^{o} phase) 1uS

Smart Grid

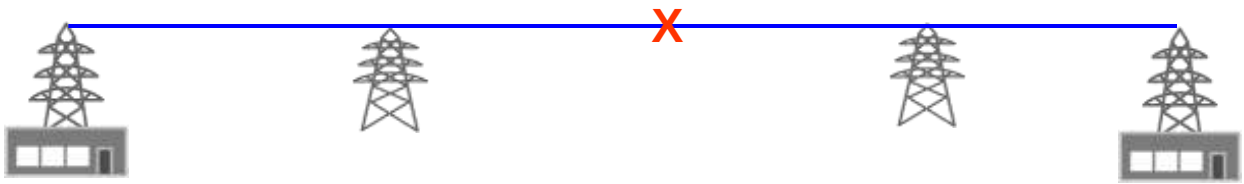
Power Transmission

Transmission network

- Transmission line fault detection

Transmission line fault detection error

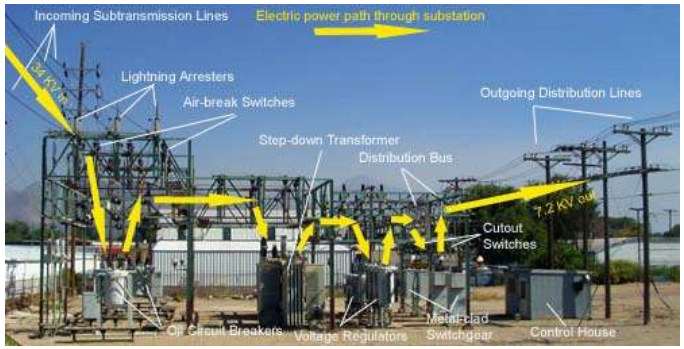
- 200 to 300 meters / uS (depending on VF)



Smart Grid

Power Distribution

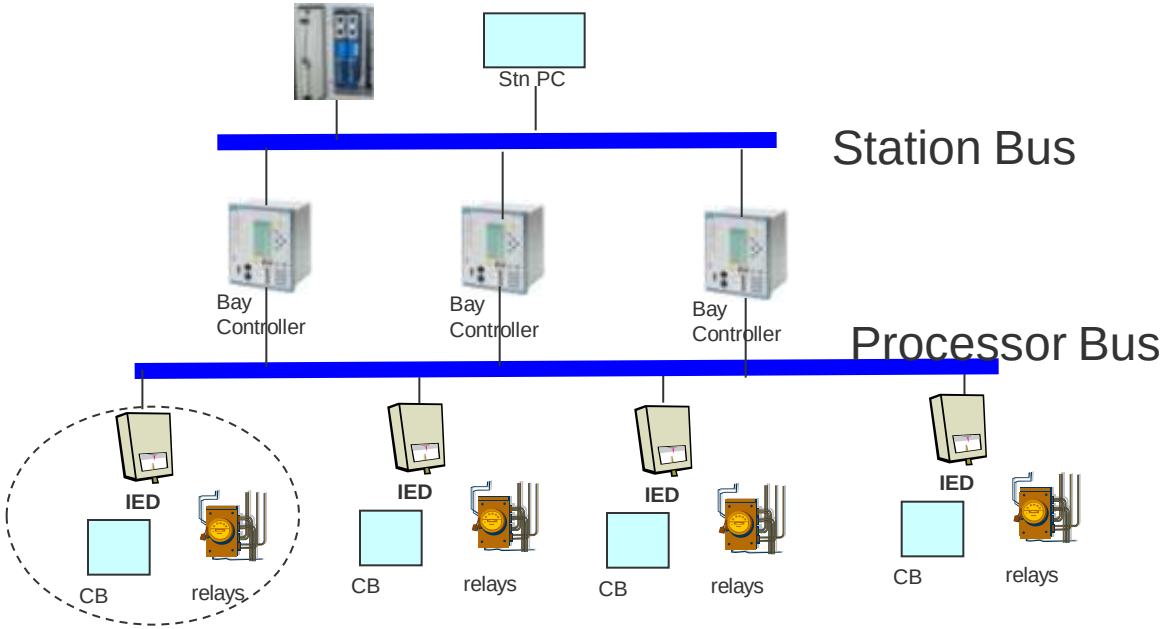
Distribution Sub-station



SCADA systems

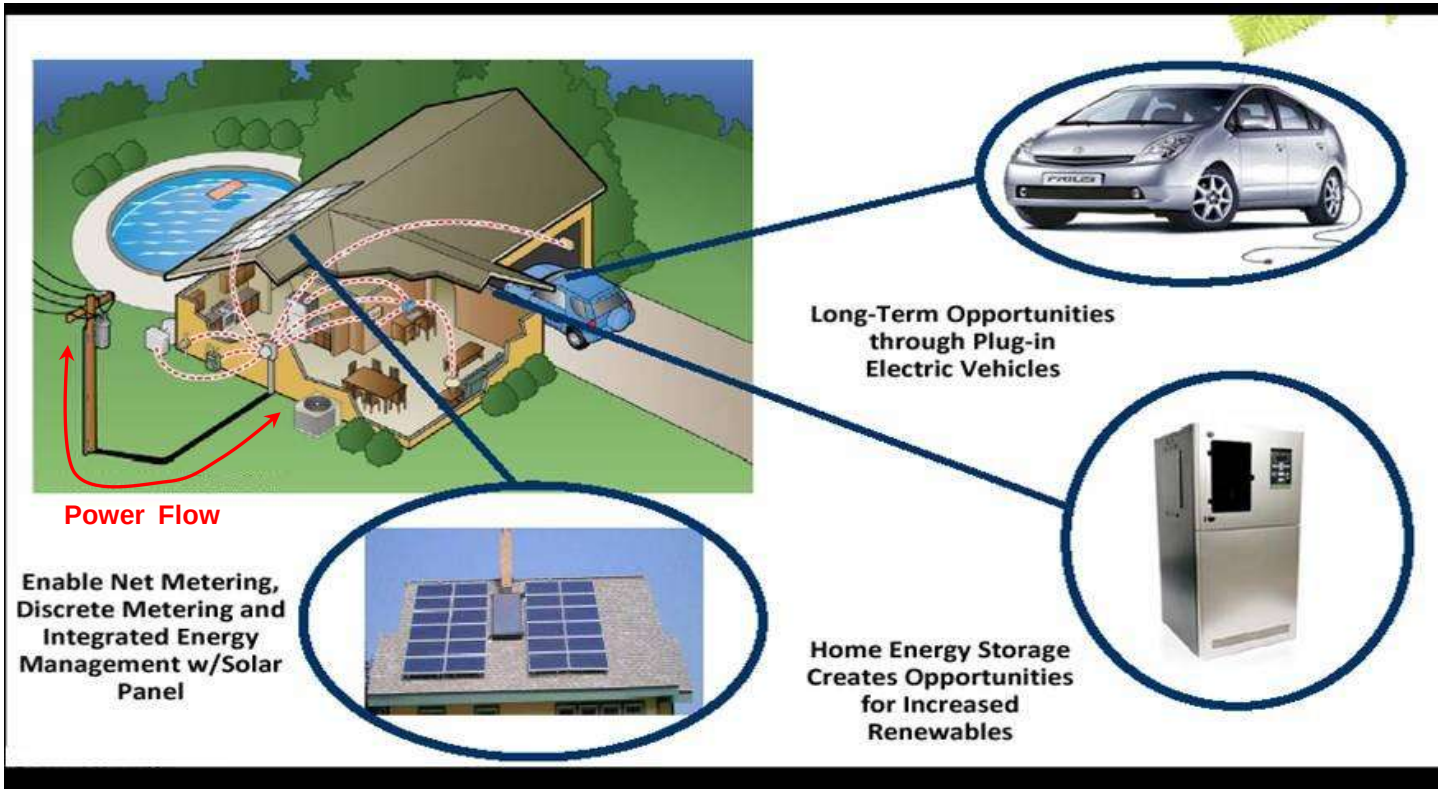
- Control
- Phasor Measurements
- Event recording

Control Hierarchy



Smart Grid

Consumer/ Consumer Producer



- Control
- Event Recording
- Metering

Smart Grid Requirements

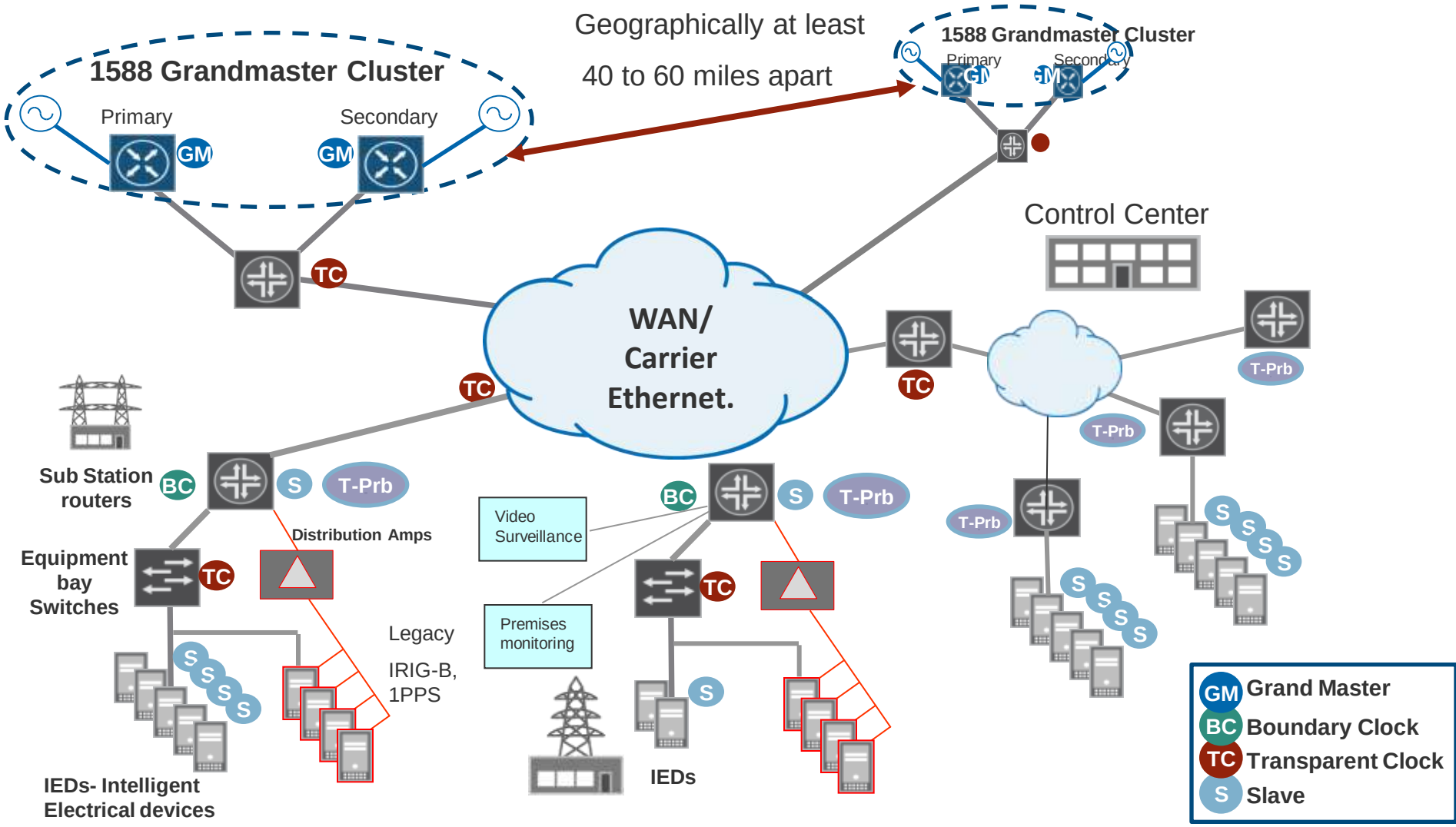
Typical permissible (time error) ranges are

Application	Range of time Error
Fault location	~1uS
Synchrophasors	1-10uS
Differential protection	1-100uS
Fault logging	10uS-5mS
SCADA applications	<1mS -100mS
Metering Applications	> 1mS

Most of these could be met with existing technology !!

Smart Grid

Transmission/ Distribution Network



Power Grid is

- Critical infrastructure
- Severe environmental & Electrical conditions

Network Design requirements

- Security & IDP
  - Extensive logging of Commands
  - Profiling
  - White listing of Protocols
- Environmentally & Electrically Hardened Network Elements
  - IEEE 1613
  - GR 3108/ 487 Class 2/4 or similar

Financial Sector

Financial Sector/ Data center/ Cloud computing

Financial Sector has changed substantially in recent years

However, Some things never Change

"Time is Money !!"

My colleague is presenting on this topic….

……. Later in this session

Cloud Computing

Cloud computing — Definition & Characteristics

Cloud computing is a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction.

(Peter Mell, Tim Grance- NIST - Effectively and Securely Using the Cloud Computing Paradigm)

Characteristics of the cloud model

- On-Demand
- Ubiquitous access
- Scalability
- Resource pooling
- Pay-per-use

Cloud Computing

Key Issues

Security
- Is my data being backed up regularly?
- Is the data in a secure location?

Privacy
- What type of encryption techniques are used for my data?

Availability
- Do I have access to my data and services at all times?
- Can the service provider guarantee service availability?

Cost
- Cloud services are variable costs, so how do I plan a budget for such services?
- How can I convert these variable costs to more predictable fixed costs?

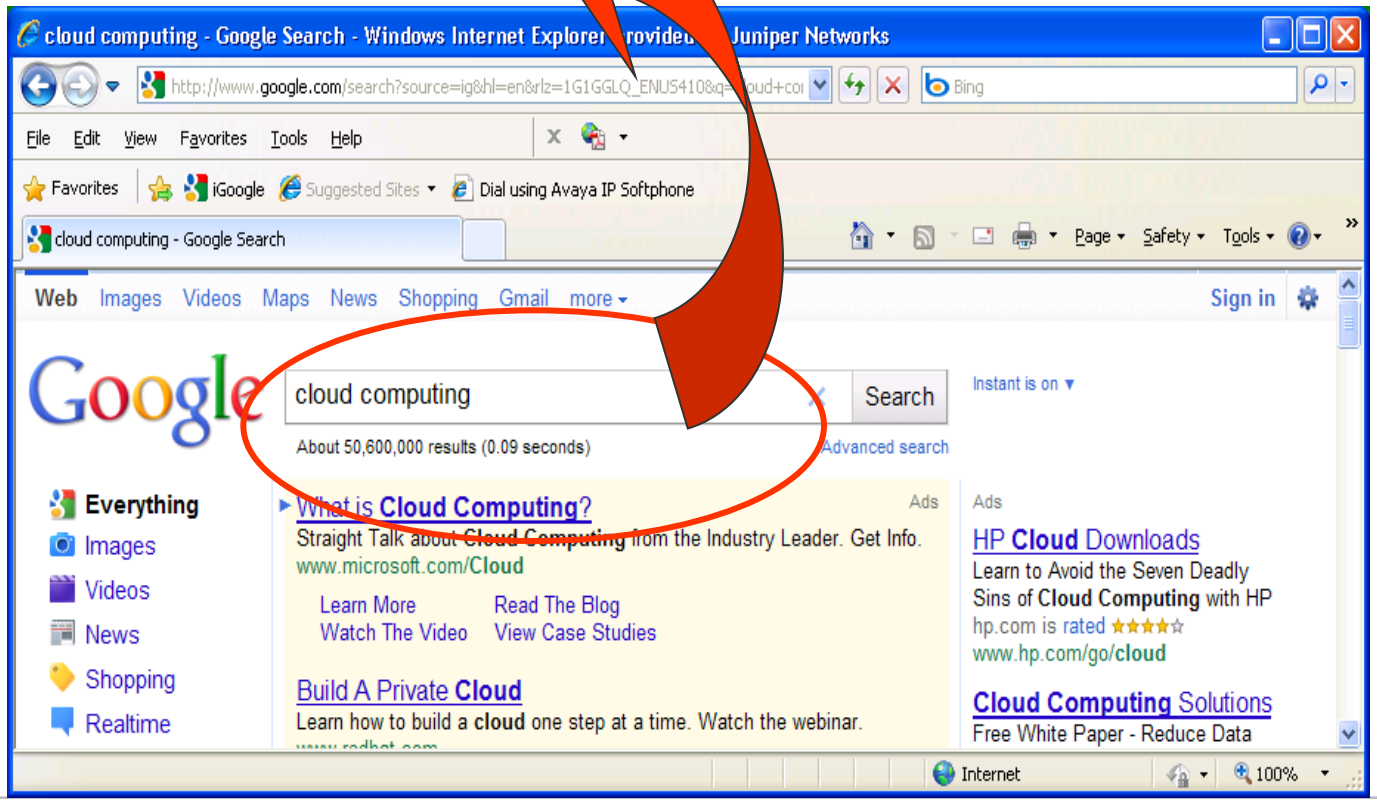
Performance
- What standardized metrics are available to measure quality of service?
- How can SLAs be implemented and managed?

Cloud Computing

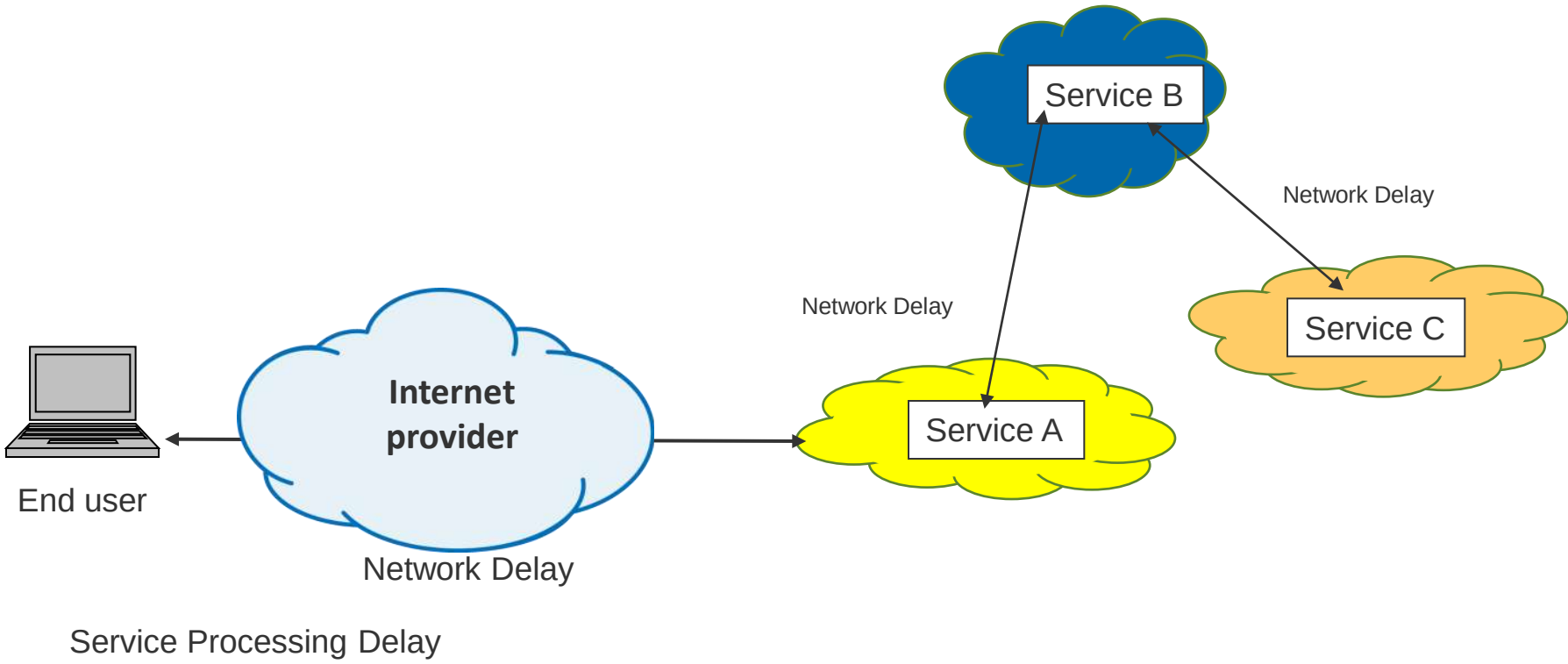
If you search for “cloud computing” on the cloud !!!

Results from search

About 50 million results in 0.09s



Cloud computing Service Access Example



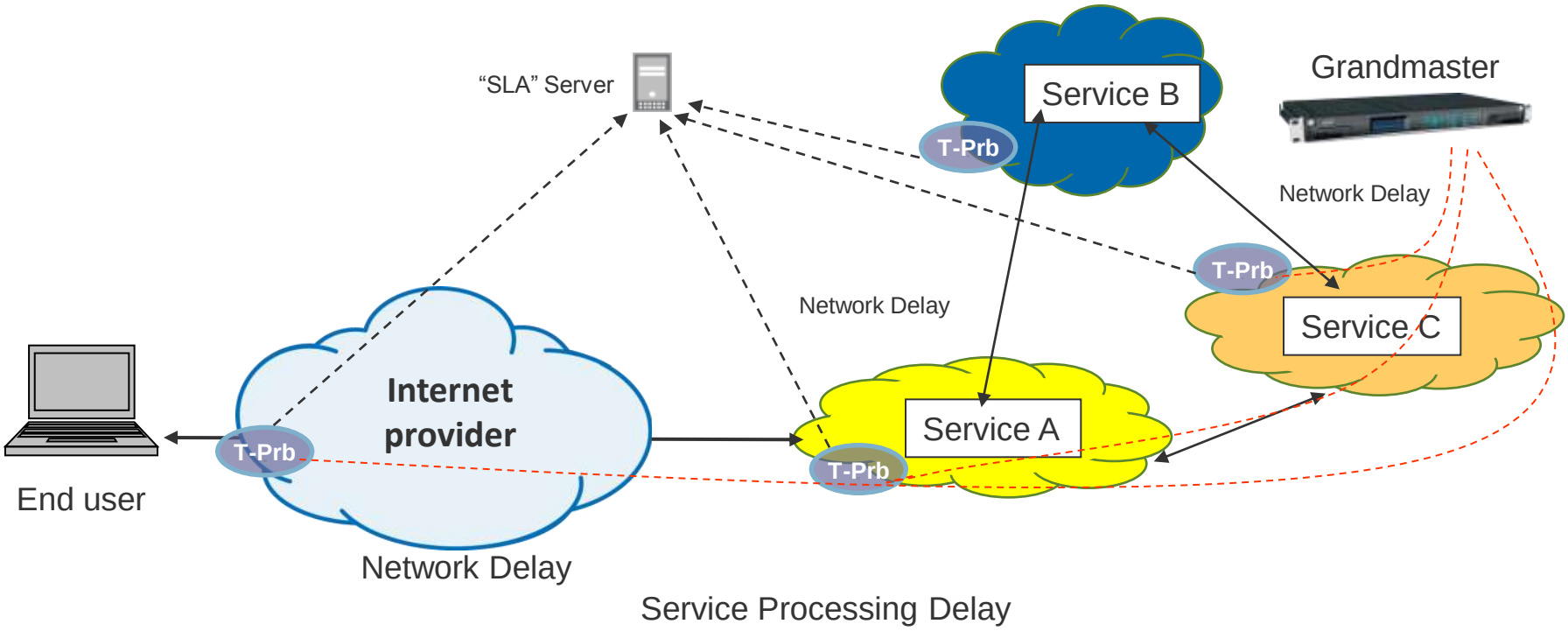
Assume that the end-user invokes Service A, which in turn invokes Services B and C

Total delay experienced by end-user is

Processing time for services A, B, C + total network delay (including network delays between services)

Cloud computing

Service Delay Monitoring



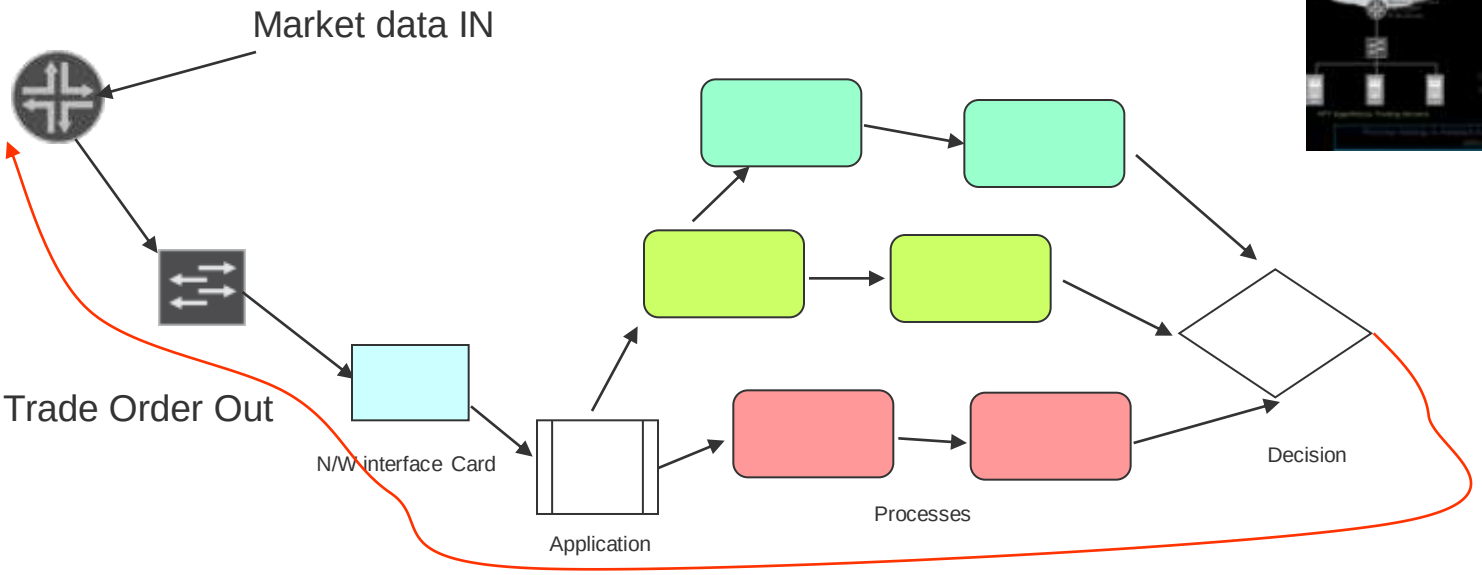
Probing agents deployed at strategic points in the network & servers capture

- Delay information
- Service processing time

Provide real time and historical data

Threshold Crossing Alarms for early warning of impending network problems

Let us extend the concept to HFT* Servers



Probing agents deployed at strategic points in the network & servers capture

- Network delay information
- Process to process delays
- Processing times

* HFT: High frequency Trading

We have requests to provide the accuracies of

Measurement of NE latencies : (sub)-Microseconds

Process delays : 0.1uS (100nS)

Process “service” times: 0.1uS

Security/ Authentication

Security/ Authentication

In my “quick” research

- A number of authentication algorithms are based on loosely synchronized clocks

Question for this community

- How can these algorithms be improved with tight synchronization
  - More robust algorithms
  - Narrowing the window of vulnerability

Intelligent Transportation Systems

Intelligent Transportation Systems

This is relatively a broad topic

- Intelligent Traffic signal Management
- Video analytics
- Information & alerts

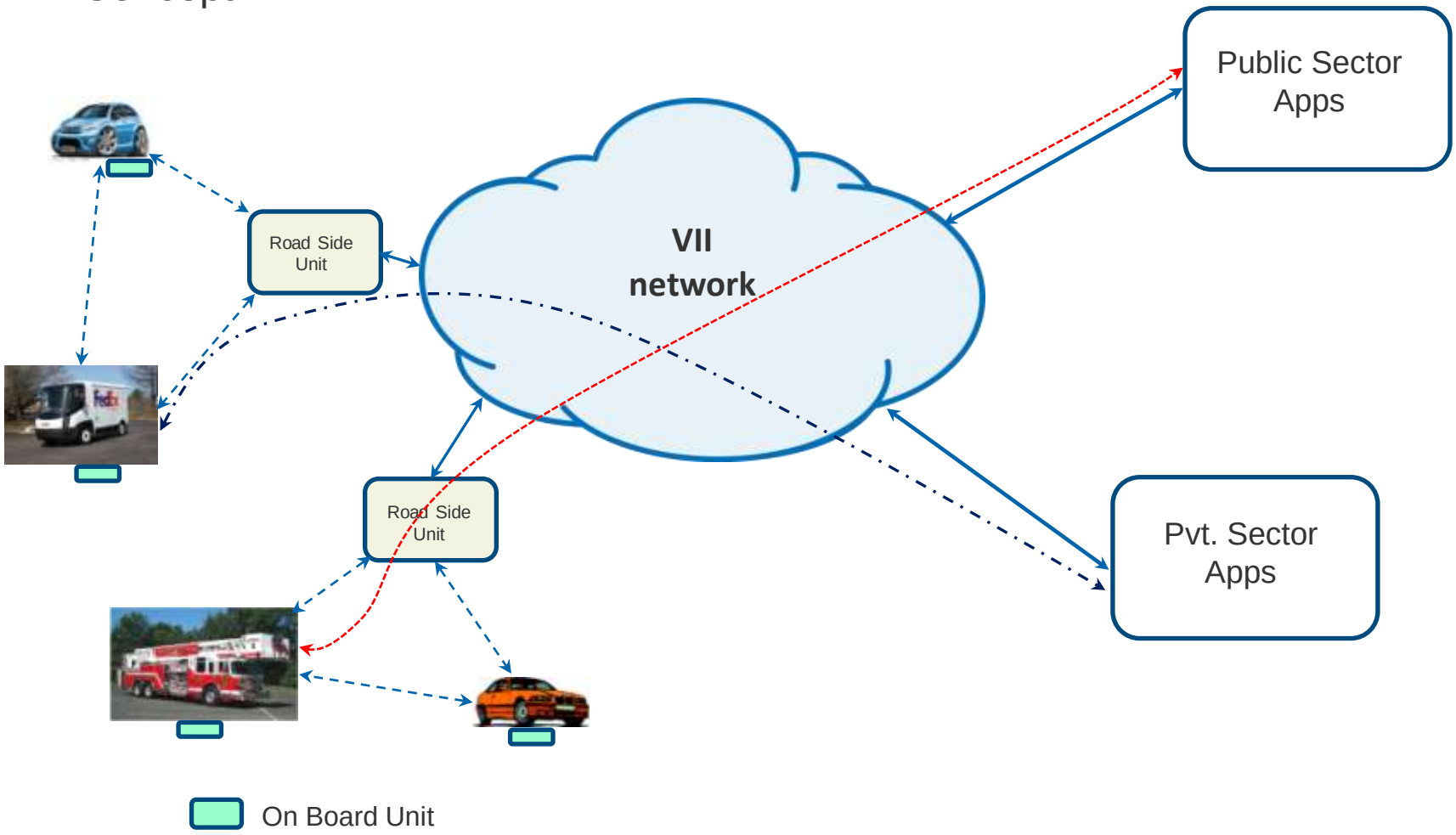
- This section would concentrate on
  - Vehicle Infrastructure Integration/ “Intellidrive”
    - Effort is to standardize Vehicular communication
      - Among Vehicles(V2V)
      - Vehicle to infrastructure (V2I)

- V2V: Enabling advance crash avoidance

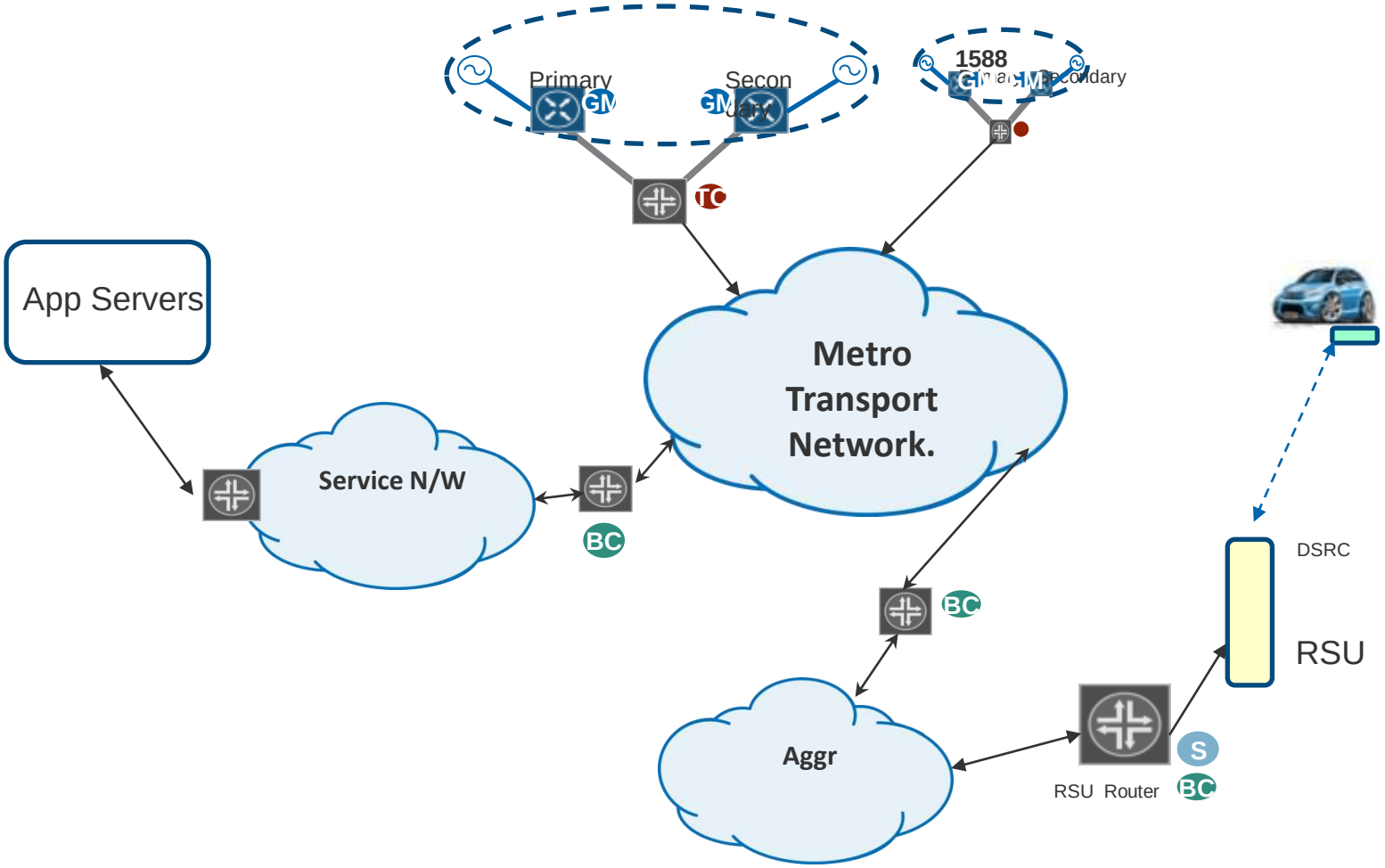
- V2I: Collecting Roadway condition information & sending alerts , related traveler information back to vehicles

Intelligent Transportation Systems

VII Concept



Intelligent Transportation Systems



Intelligent Transportation Systems

The objectives of ITS

-
- Provide Core services
  - Publish/subscription services
  - Network management
  - Certificate Authority
  - Mapping and positioning services

- Most other aspects of ITS are similar to the topics already discussed !!

Intelligent Transportation Systems

- Positioning service goal

  “95% Circular Error probability”

  1m translates to ~3nS.

  Can this be achieved?

With Combination of

- GPS assisted by PTP over CCH channels
- Multiple sensor data
- Low cost relative positioning methods

Opportunities

Smart grid

- Development of accurate power system models
- Advanced systems management based on models & Real time data

Financial

- Time monitoring services
- Real time forensics/ fraud detections

Security

- Improved Authentication algorithms

Intelligent transportation

- Limited only by imagination !!

Ending Remarks

PTP provides a method to ubiquitously Transfer time over any packet network.

We considered a few applications of PTP outside of traditional telecom networks

With the intent that this community comes up…….

…… with many more.

References

Smart grid

Cristoph Brunner- Information technology for smarter grids, ISPCS 2010

Jeff Fletcher et. Al. – Using clock accuracy to guide model synthesis in distributed systems, ISPCS 2010

Financial

http://www.endace.com/assets/files/announcements/20110201_Endace_MiFID_II_Comments.pdf

Cloud computing

Peter Mell, Tim Grance- NIST - Effectively and Securely Using the Cloud Computing Paradigm

ITS

A detailed overview of the U.S. DOT's IntelliDrive initiative
http://www.fhwa.dot.gov/publications/publicroads/10julaug/04.cfm

Final Report: Vehicle Infrastructure Integration proof –of –concept

Questions

everywhere