

Sync in an NFV World

  
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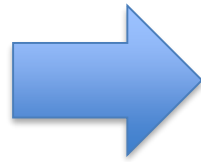
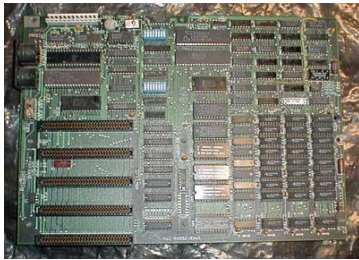
# Sync in an NFV World

- What is Virtualisation? What is NFV?
- Standards for NFV
- Why does NFV affect sync?
- Challenges, Questions, Thoughts
- Summary

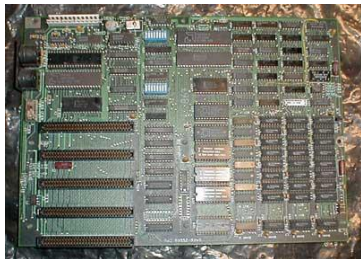
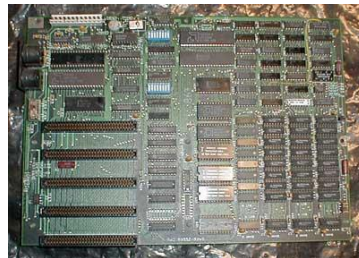
# What are Virtualisation and Network Function Virtualisation?

# Virtualisation

Doing in software what is traditionally done in hardware by emulating the hardware



```
role_id' => $role_details['id'],
'resource_id' => $resource_details['id'],
);
if ( $this->rule_exists( $resource_details['id'], $role_details['id'] ) ) {
    if ( $access == false ) {
        // Remove the rule as there is currently no need for it
        $details['access'] = ! $access;
        $this->_sql->delete( 'acl_rules', $details );
    } else {
        // Update the rule with the new access value
        $this->_sql->update( 'acl_rules', array( 'access' => $access ) );
    }
}
foreach( $this->rules as $key=>$rule ) {
    if ( $details['role_id'] == $rule['role_id'] && $details['resource_id'] == $rule['resource_id'] ) {
        if ( $access == false ) {
            unset( $this->rules[ $key ] );
        } else {
            $this->rules[ $key ]['access'] = $access;
        }
    }
}
```



We replace this



With this



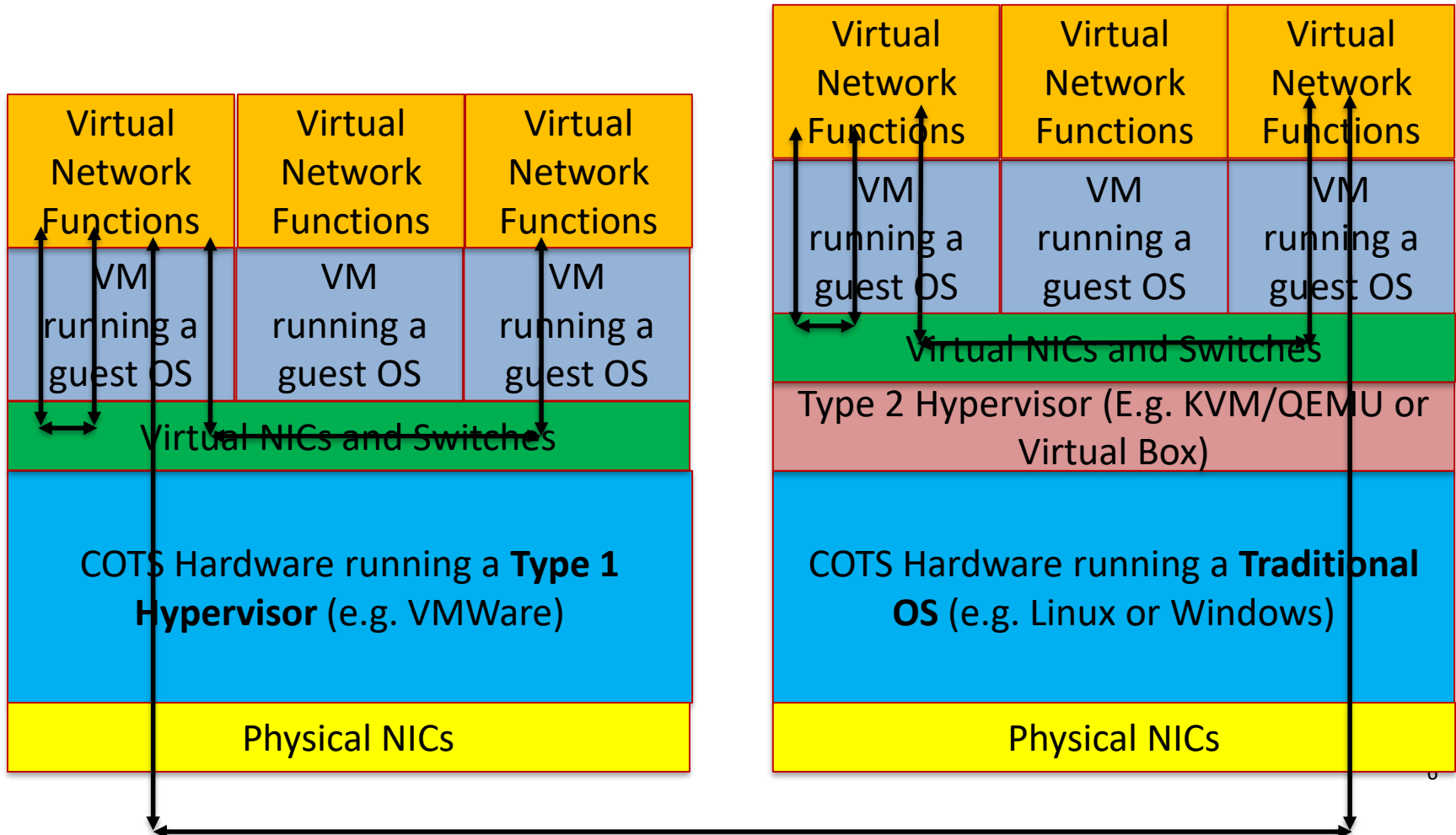
# Virtualisation Layers

COTS = Commercial Off the Shelf System

OS = Operating System

NIC = Network Interface Card

VM = Virtual Machine



## Why adopt NFV?



+



Massively Increased Flexibility  
Greatly Increased Speed of Deployment  
and Reconfiguration

# Standards

# ETSI NFV Reference Architecture

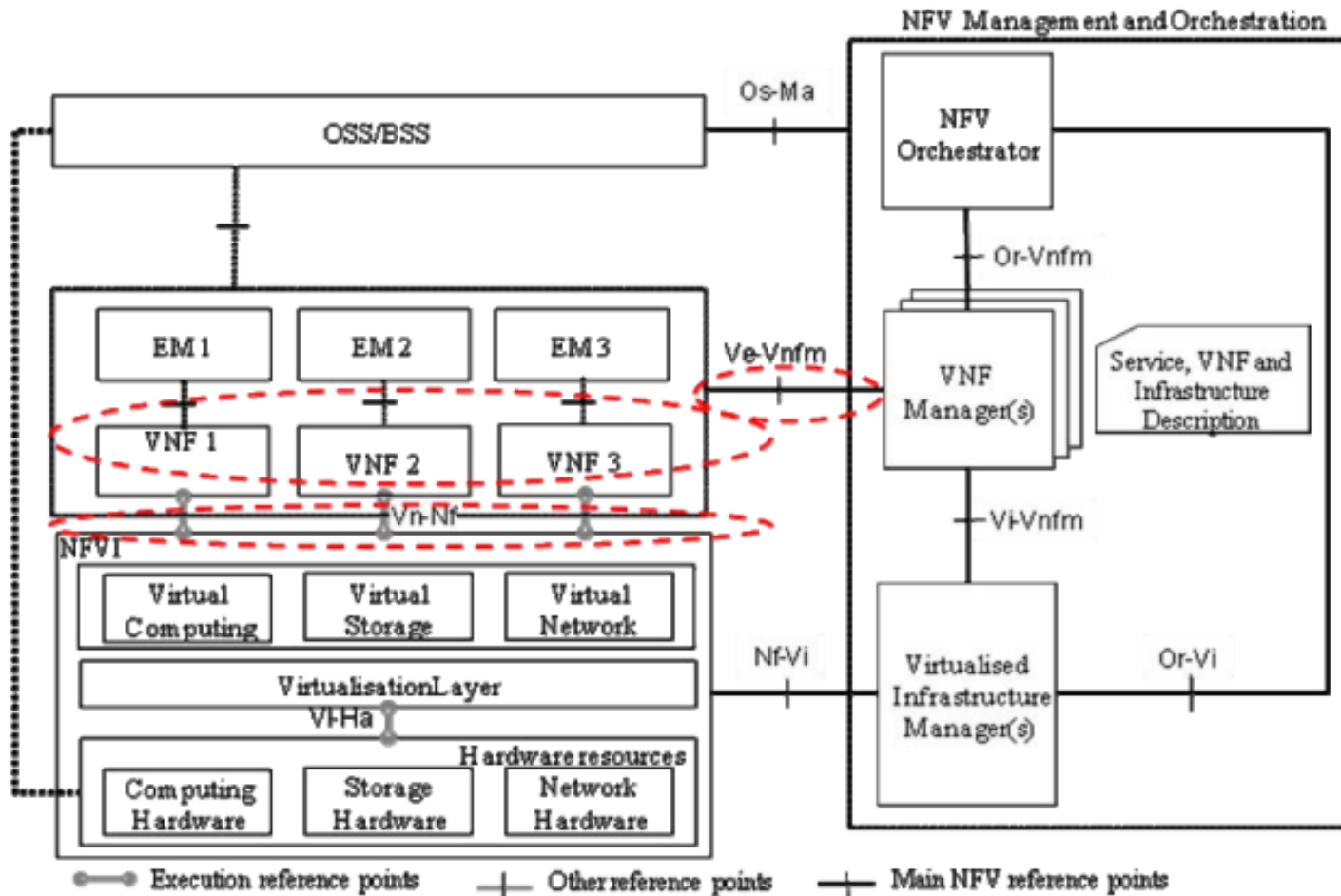


Figure 1: NFV Software Architecture Scope within the NFV Reference Architecture Framework

# Standards for NFV Sync



- ETSI have finalized several Standards, Recommendations and Use Cases for NFV.
  - <http://www.etsi.org/technologies-clusters/technologies/nfv>
- Virtualization Requirements document, Section 5.8:
  - [http://www.etsi.org/deliver/etsi\\_gs/NFV/001\\_099/004/01.01.01\\_60/gs\\_NFV004v010101p.pdf](http://www.etsi.org/deliver/etsi_gs/NFV/001_099/004/01.01.01_60/gs_NFV004v010101p.pdf)
  - Service Assurance suggests the use of IEEE 1588 timestamps
  - Implemented on the NIC to establish a common time base for physical layer and upper layer processes
  - Timestamps to be used as precise time labels for all event processes

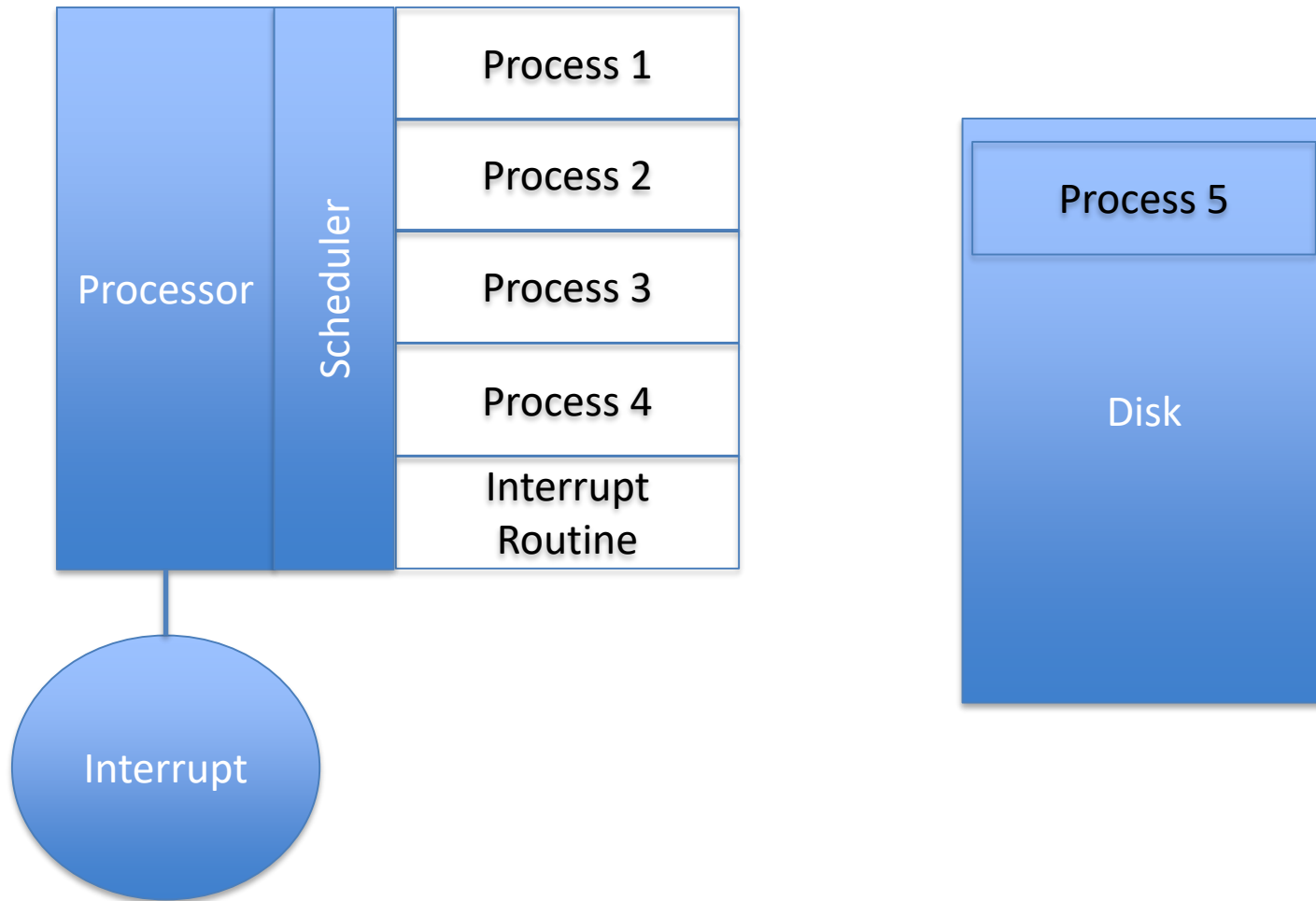
Why does it affect Sync?

# Why Does it affect Sync?



- 1) Accurate Sync needs deterministic elements and quality components
- 2) Software is both slower and less deterministic than hardware
- 3) The underlying processor hardware is usually clocked by a relatively low quality oscillator

# What Makes Software Less Deterministic?



The processor is usually shared between multiple processes.  
The number of active processes typically varies dynamically.  
Processes can be swapped out to disk to make space – this takes time.  
Interrupts can happen at any time – disrupting the flow of operations

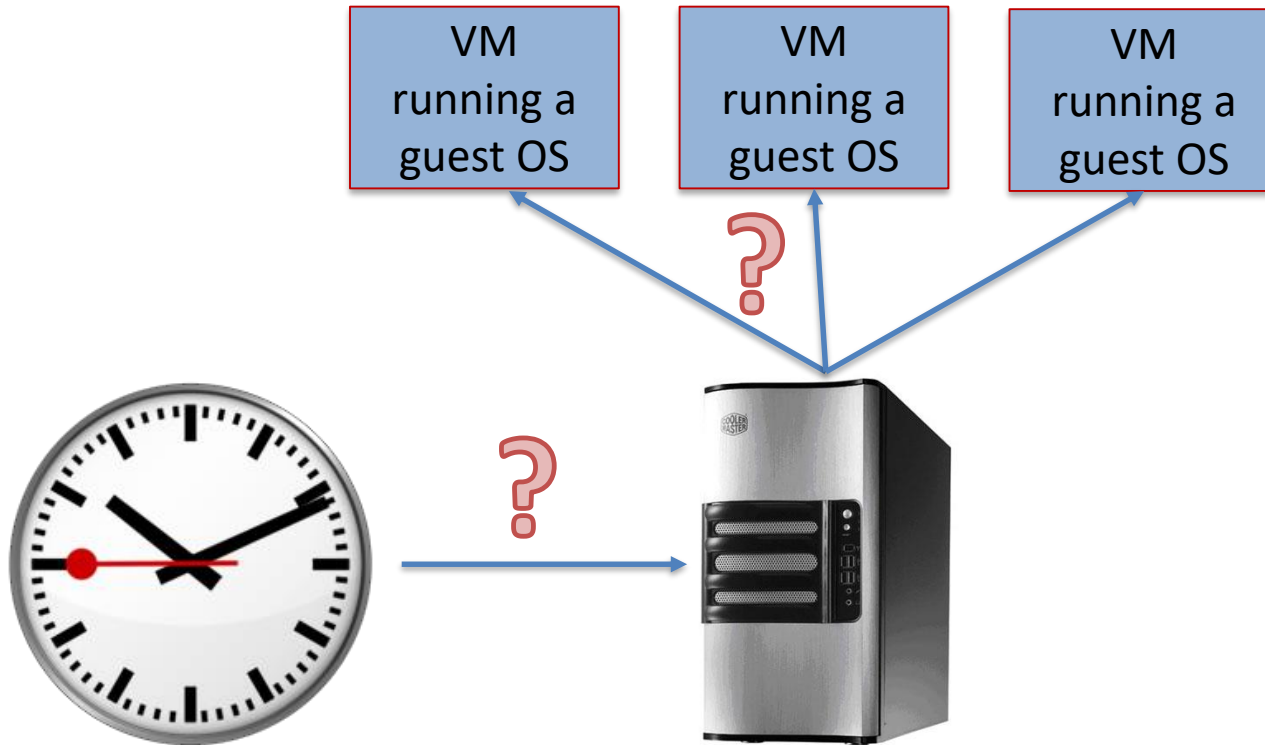
# What Else Makes Software Less Deterministic?



- 1) Memory access times vary depending on type  
cache, static, dynamic, virtual, etc.
- 2) Modern processor techniques make predictability difficult.  
Predicting exactly how long a sequence of instructions will take is very difficult
- 3) Multi-threading and different numbers of processor cores.
- 4) Processors execute at different speeds at different times  
A given piece of software will run at a different rate on different machines.
- 5) Software is written in high level languages which are then compiled  
Each time the code is changed, the sequence and therefore the timing changes.

# Challenges, Questions and Thoughts for NFV Sync

# How Do We Get Accurate Time Into a VM?



- A sync chain requires dedicated hardware
- Virtualising it will not be good enough for most real world applications
- A boundary clock is a hardware function – making use of oscillators, PLL's etc.
- As soon as we cross into the software domain, things become less predictable.

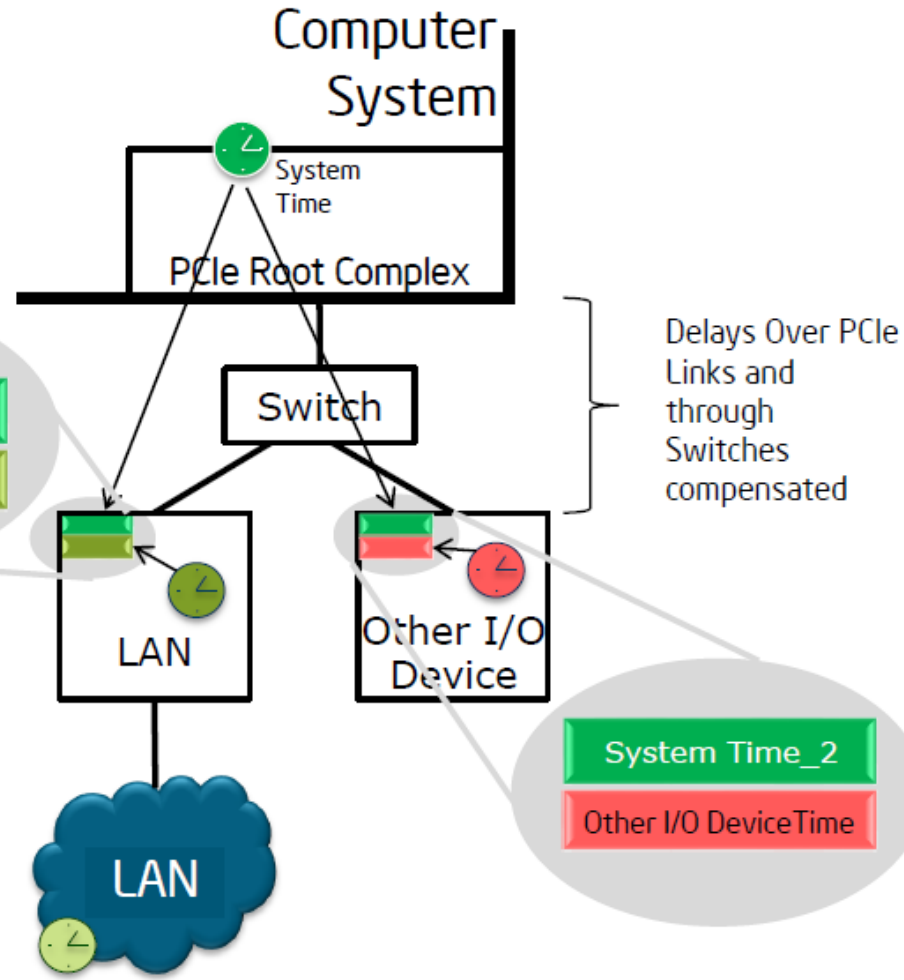
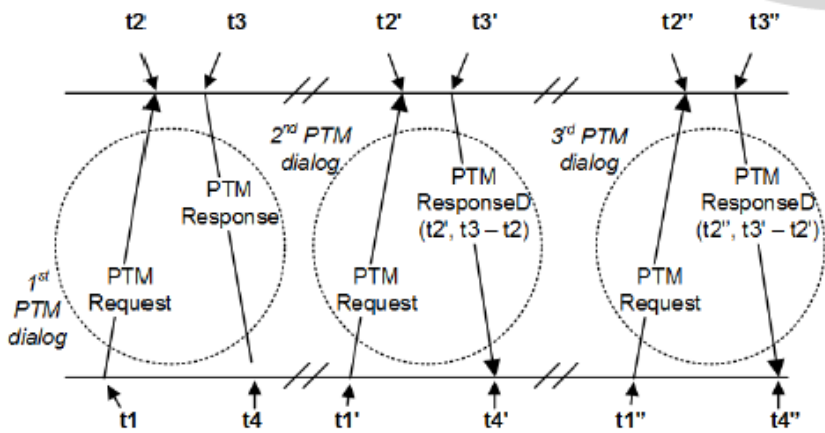
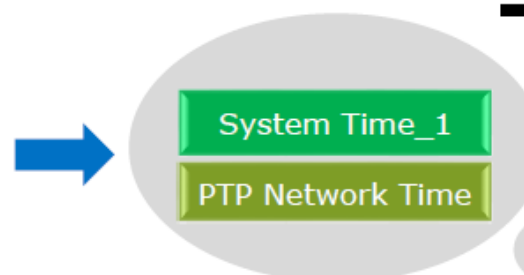
# Measuring PTP vs. System Time using PCIe PTM

(Precision Time Measurement)

Scenario:

1. Device Driver Triggers Cross-Timestamp
2. Device initiates *PTM Request* TLP to Root Complex
3. System Time is Returned (delays are compensated)
4. (PTM Time, PTP Time) returned to Device Driver
5. Software "disciplines" two variables per clock:  $m$  and  $b$

Cross Timestamps,  
Captured Simultaneously



**In-System Cross Timestamps → Time Translation Coefficients**

## An example from Finance

FSMLabs TimeKeeper based system holds Amazon VM instances to within 10 microseconds accuracy over internet

High precision time source

AWS instance that

acts as boundary clock to serve slaves within the AWS cloud

External GM compares returned time to GPS

Lessons: Connectivity to cloud instances is key. Enormous variation depending on VM technology. Possible to sync reasonably well with off the shelf technology now given smart enough smoothing.



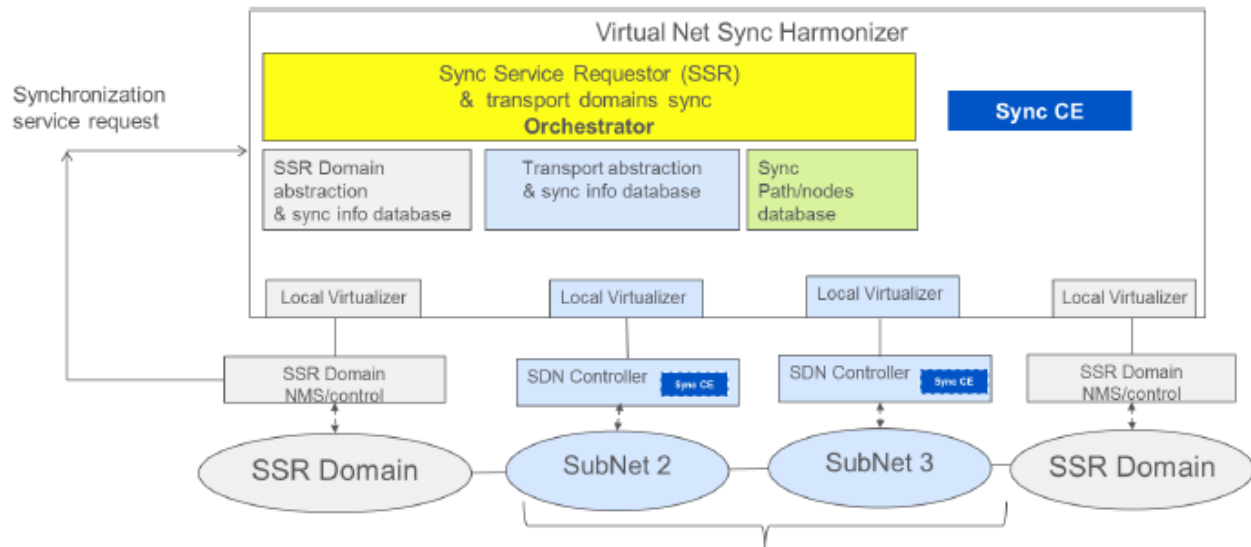
# A suggestion for Telecoms

## SYNC AS A SERVICE ARCHITECTURE



› Harmonization layer on top of each domain that allows harmonizing such domains. The overall architecture is based on the following key components:

- *Virtual Net Sync Harmonizer*, that receives relevant information from each domain through standard interfaces
- *SDN Controller/Local Virtualizer* pairs that collect information on a specific domain at a suitable abstraction level, and that properly sets up the domain

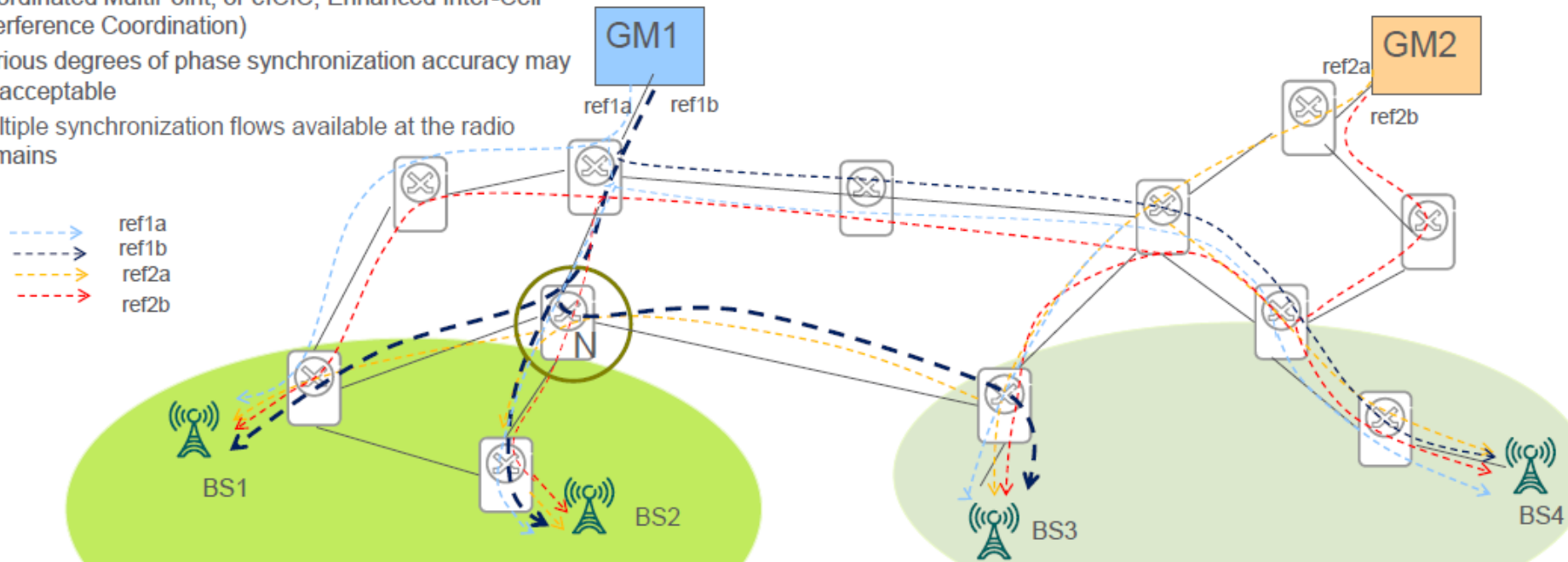


# A suggestion for Telecoms (contd.)

## EXAMPLE: CLUSTER OF BASE STATIONS



- › Various and variable clusters of base stations.
- › Local phase synchronization (e.g. to implement CoMP, Coordinated MultiPoint, or eICIC, Enhanced Inter-Cell Interference Coordination)
- › Various degrees of phase synchronization accuracy may be acceptable
- › Multiple synchronization flows available at the radio domains



- › Policy selected: “Transparent Sync” transport
- › The Local Virtualizer looks for nodes with “1588 timing-support”
- › Phase difference per each cluster of the base stations is minimized

# Questions – Research Needed



How accurate might we be able to make a software PTP implementation?

How accurately might we be able to transfer and maintain time within a VM with or without specialised hardware?

How can we solve the measurement challenge – how to verify accuracy?

## Summary

- NFV is coming, like it or not
  - Most major operators are considering it, if not actively planning for it
  - Probably the biggest shake-up of telecoms networks since voice-data convergence 10 years ago
- Sync will be affected
  - NFV doesn't remove the need for sync, sync methods need to evolve
  - New models of operation will be established
  - New opportunities will be created
- The industry is moving forward
  - Techniques to lock SW to HW
  - Techniques to maintain SW accuracy
  - Network & equipment architecture ideas
- **Are we looking at a new generation of hardware or architecture?**