EUROPEAN CENTRAL BANK
EUROSYSTEM

BANCA D'ITALIA EUROSISTEMA BANCO DE ESPAÑA Eurosistema
BANQUE DE FRANCE EUROSYSTÈME DEUTSCHE BUNDESBANK EUROSYSTEM

TARGET instant payments settlement (TIPS) – how?

Massimiliano Renzetti
Banca d'Italia (4CB)
Focus session, 7 July 2017, Frankfurt

Table of content

Project challenges

Low latency, high volumes, high availability and resilience, scalability.

24/7/365 operations (mostly unmanned): need for re-thinking of ITSM processes.

Time and technical dependencies with other projects (T2-T2S Consolidation).

Tight plan (both for development and procurement): 511 days to go-live…

Table of content

Proof of concept

- Banca d'Italia performed in 2016 a **PoC activity** with the two following main objectives:
  - to **validate the feasibility** of a technical infrastructure providing a pan-European instant payments solutions, as defined by the ERPB and in the MIPC Instant Payments project charter;
  - to perform a **high-level assessment** of the time and cost required for building a fully-fledged instant payment solution in TARGET2.
- Scope of the **prototype**:
  - focusing on the **settlement engine**;
  - simulating the latency of **remote interactions**;
  - taking into account two main dimensions of analysis: (i) **volume** of transactions, (ii) **cardinality** of accounts.

Proof of concept

- Qualitative main outcomes:
  - keep the application **complexity** as low as possible;
  - perform a paradigm shift towards **innovative** architectures and technologies;
  - build an operational model relying on a very high service **availability** and **resilience**.
- Quantitative main results:
  - linear behavior up to **25,000 transactions** per second (i.e. more than 2 billions transactions per day);
  - response time and linearity not influenced by the number of accounts (up to **100 millions** of **accounts**);
  - overall response time per transaction below **5 seconds**.

Table of content

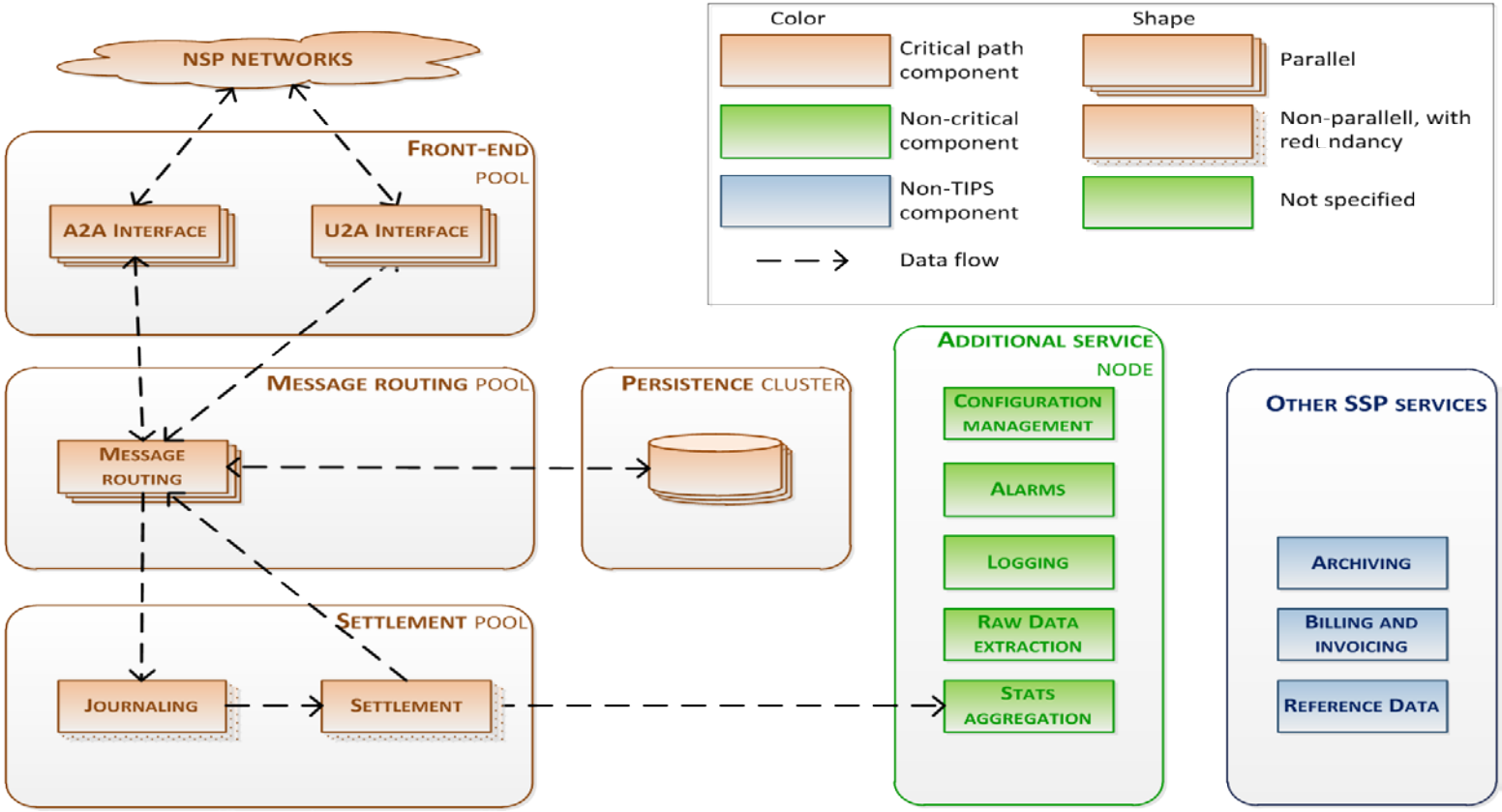
Architecture pillars

- High use of **in-memory processing**
  - The settlement engine does not store any information on a database *(shared nothing* approach as opposed to the traditional multi-threaded programming*).*
  - Consistency, transactional integrity and data persistency is ensured by a dedicated *Journaling* component.
- Streaming **architecture**
  - Each software component processes its input stream and feeds its output stream by means of asynchronous messages.
  - This approach avoids the spread of waits and locks typical of a synchronous approach and allows each component reaching its maximum speed.

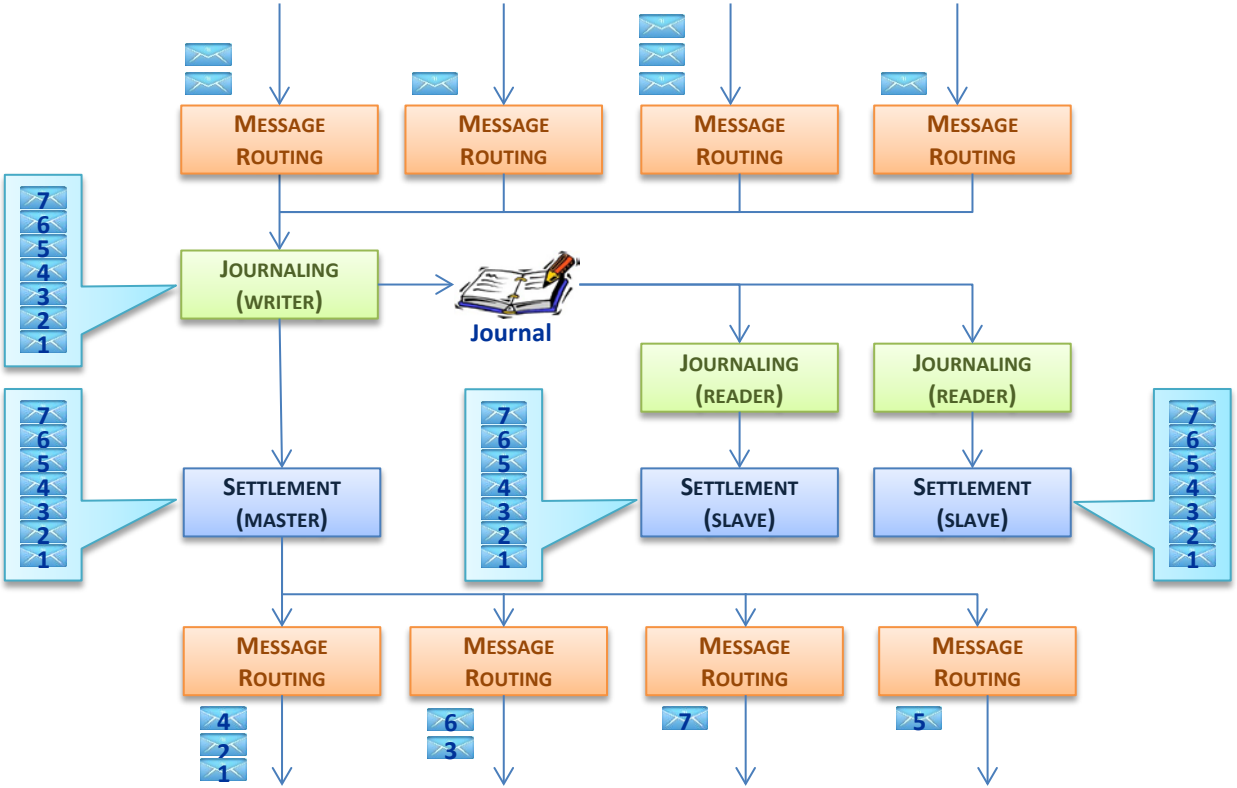
Architecture pillars

- Deterministic **status transition**
  - The internal status of the application is determined by its input stream only. Therefore, the processing of the same input stream ensures multiple instances of the settlement engine reach the very same status.
- **Resilience** through application redundancy
  - Multiple instances of the settlement engine run in parallel, each of them processing in sequence the same input stream.
  - The output stream of one of them only (the *master* instance) is used to send messages out of TIPS.
  - In case of failure, another instance of the settlement engine takes over, reaching the same status and producing the same output stream of the failed instance.

Architecture overview



Architecture overview



TIPS in the Vision 2020

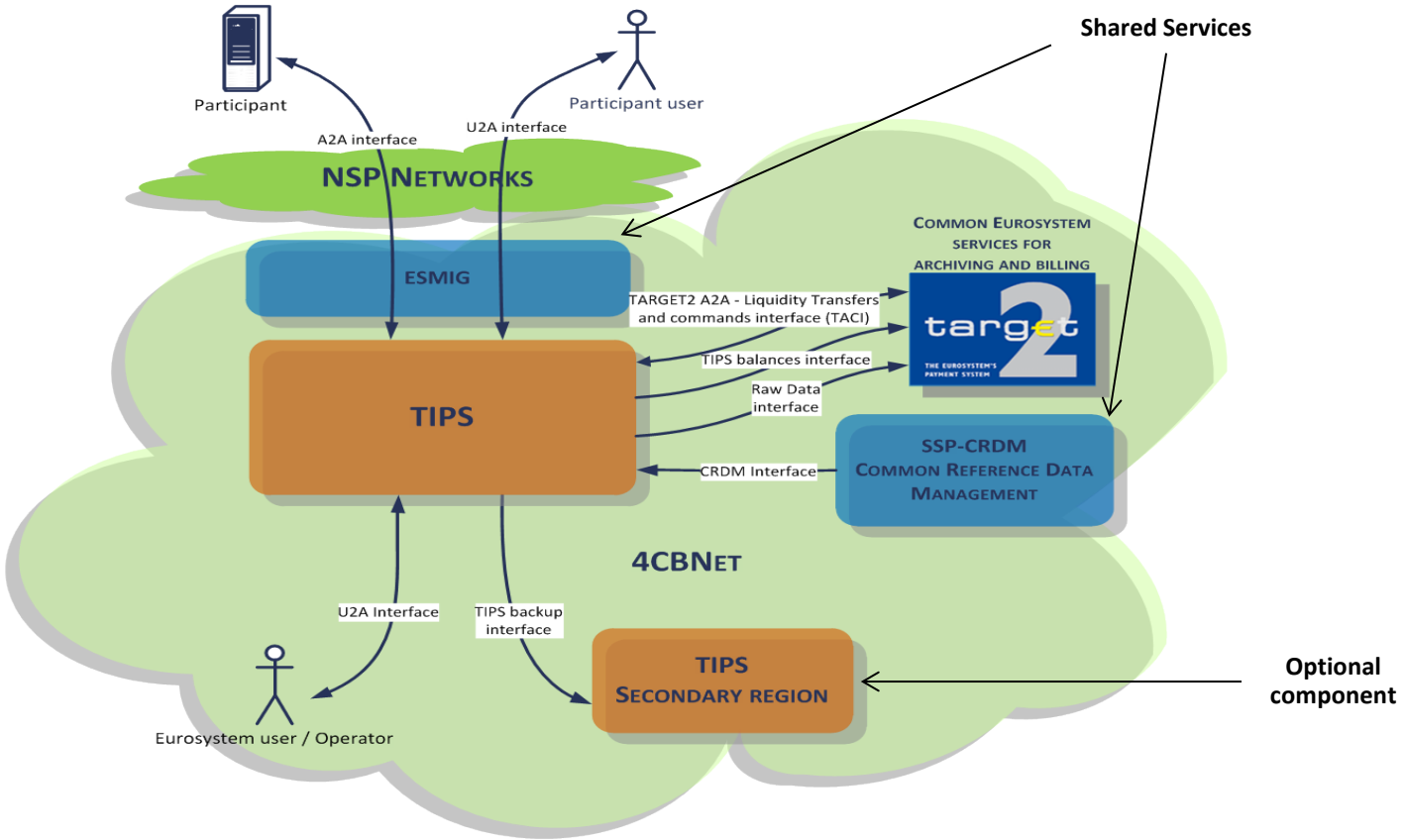


Table of content

Operational model

To contain the running cost of a 24/7/365 service, the operational model should target a ***zero-incident framework***.

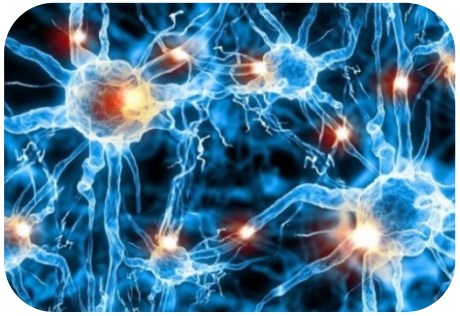
- The service can run without the need of human resources available 24/7/365.

Operations Monitoring

Issues not implying service disruption are handled during normal working hours. Only incidents implying a service disruption are addressed immediately.

Self-healing Application

Handling application failures without stopping the service. Application resilience based on redundancy of application nodes.



Self-healing Infrastructure

Infrastructure resilience through hardware and network redundancy. Virtualization to allow an efficient usage of system resources.

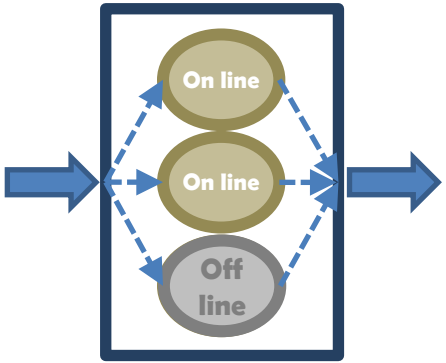
Change management

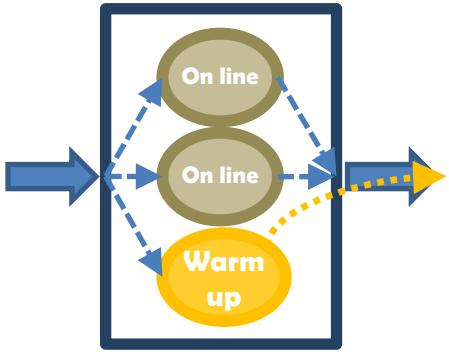
- Changes in TIPS shall occur during normal service hours, without any service interruption (no maintenance window).
- This principle applies for all types of changes, e.g.:
  - new application releases;
  - new XML message ISO versions;
  - system configuration updates;
  - system software updates;
  - infrastructure changes.
- To allow seamless operations of the settlement service, any change has to be
  - designed so that it can also work in *compatibility* mode (wherein old and new behaviors may coexist);
  - deployed according to a phased approach.

Change management

Phase 1

The node to be upgraded is put off-line.





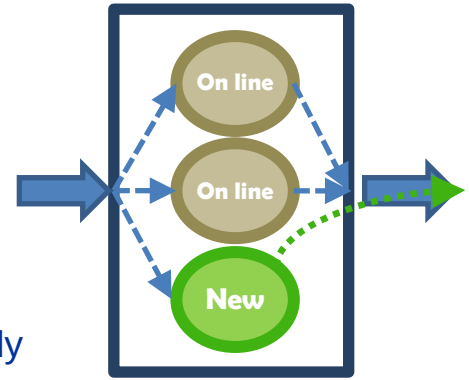
Phase 2

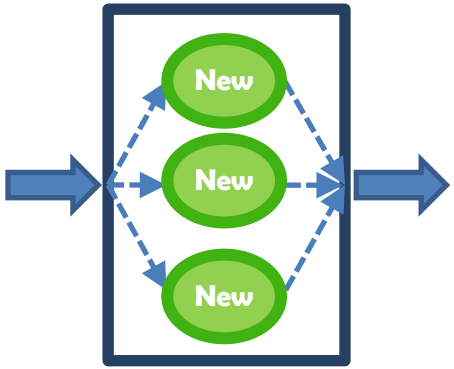
The upgraded node start working with the new application version, but its output is not yet sent out.

Phase 3

The upgraded node is fully operational.

Users may receive TIPS outgoing messages both from old nodes and already upgraded nodes.





Phase 4

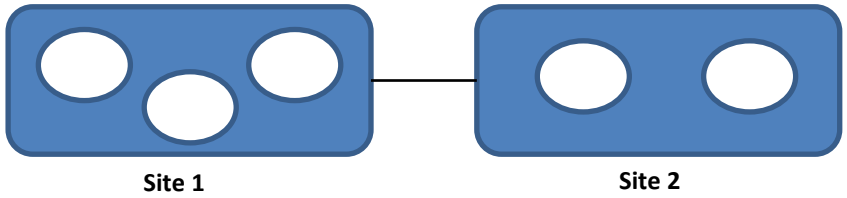
All nodes are upgraded.

Only the new application version is running.

Table of content

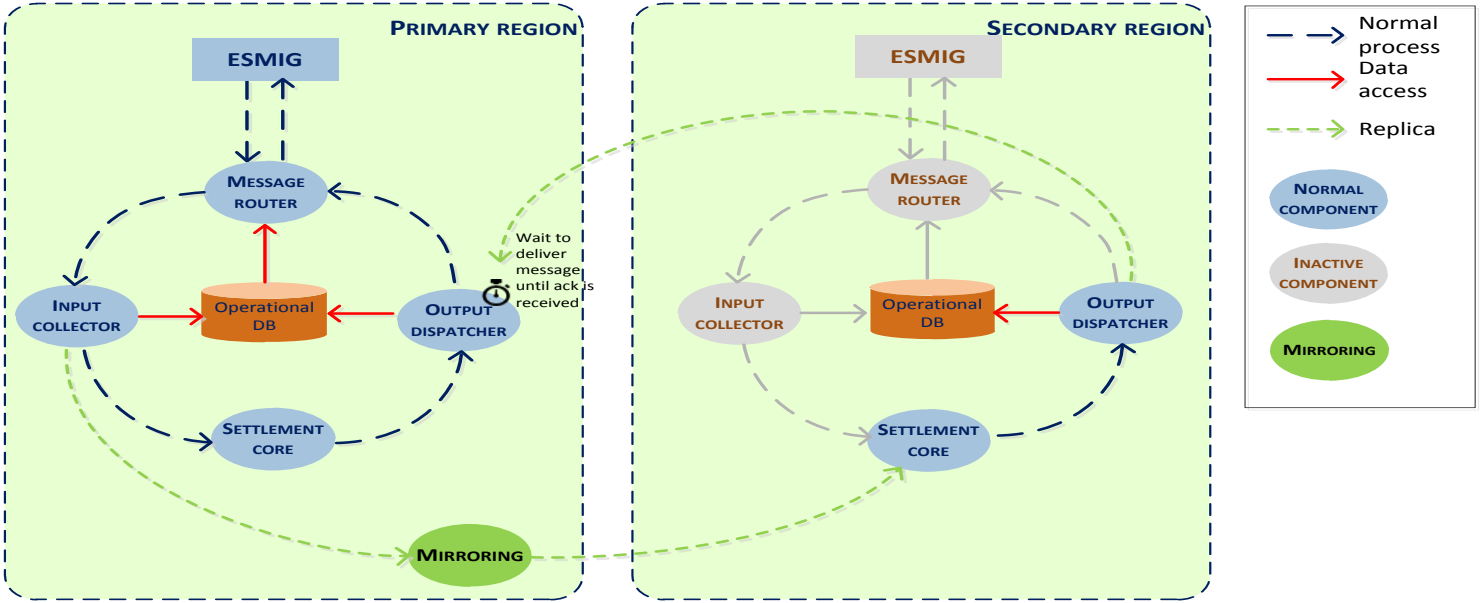
Business continuity

- The TIPS infrastructure is a cluster of processing nodes playing different roles (e.g. Message Routing, Settlement Core, Persistent Storage).
- Only one of the Settlement Core nodes plays the role of *master*). In case of *master* failover, one of the *slave* nodes becomes the new *master* (by means of *quorum-based* algorithm).
- The implemented topology will be based on two sites with different number of nodes (so to prevent the so-called *split brain* condition).



Business continuity

Optionally, a second region may be implemented in the future to allow the management of a regional disaster scenario.



Thank you for the attention!

Massimiliano Renzetti

BANCA D'ITALIA – PAYMENT SYSTEMS DIRECTORATE

EUROSYSTEM MARKET INFRASTRUCTURE DIVISION

massimiliano.renzetti@bancaditalia.it