Teamcenter Digital Lifecycle Management Solutions

Reference Architecture
Changes from Teamcenter 2005
Teamcenter 2007.1 Performance
Forward Look
Summary
Reference Architecture
Four-Tier Objectives and Benefits

Increase deployment flexibility
- Allow separation of web tier and business logic
- Allow deployment of rich clients across WAN from central servers

Reduce administrative cost of distributed deployment
- More “standard” deployment/IT architecture
- Easier configuration of firewalls
- Easier client software install and maintenance

Increased Scalability
Reference Implementation Architecture

**Client Tier:**
- Host client applications
- Provide user interface input and output processing
- Host secure file caches

**Web Tier:**
- Route client requests to business logic
- Serve static content to clients
- Process login requests

**Enterprise Tier:**
- Host business logic
- Apply security rules
- Serve dynamic content to clients
- Store persistent meta-data (tables)
- Store bulk data (files)

**File Cache Servers:**
- Host shared file caches for rapid client access

**Resource Tier (Filestore):**
- Store persistent bulk data (files)

**Resource Tier (DB):**
- Store persistent meta-data (tables)

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Siemens PLM Software
4-tier has WAN-friendly and firewall-friendly characteristics

- HTTP protocol between client and web tier
- Server calls (instead of database calls) over WAN -- for “Expand BOM” use case:
  - 18 server calls
  - 2693 SQL calls
- Large responses (> 500b) are compressed for WAN transport

Sources of additional overhead in 4-tier

- One more process boundary
- Two machine boundaries
- Web Tier processing

Performance implications

- Chattiness allows 4-tier overhead to accumulate
- But, with a slower network between user and DB, 4-tier can perform better than 2-tier
Truisms

“Everybody Knows” that on a “near zero” latency network – 2 tier will be faster than four-tier

- BUT in Teamcenter 2007.1 (unified architecture) the difference is very slight – and darn near insignificant
- AND the pattern reverses at surprisingly low latency levels – as low as 5 milliseconds

The nature of the difference is the extra overhead contributed by the extra levels of the 4 Tier Architecture

- The amount of difference depends on both specific use case and client
- The amount of difference is being reduced each release as the overhead is reduced
- Caution: restricted bandwidth can skew results, especially with file transfer
Nature of Overhead

Rough approximation of the total 4-tier overhead per call (based on experiments):
- 5ms + (kb of payload)(0.3ms/kb)
- In Tc2005SR1 was 20ms + (kb of payload)(0.25ms/kb)
- Includes: HTTP, Web tier and machine hops

As a percentage, overhead can vary wildly depending upon:
- Request execution characteristics
- Relative speeds of the networks and hardware at each tier.

Example 1
- tcserv processes request for 1 second and returns a 40K response
- Overhead = 17ms/1000ms = 1.7%

Example 2
- Tcserver processes request for 20ms and returns a 4K response
- Overhead = 6.2ms/20ms = 31%

RAC calls are often of the second type rather than the first

NOTE: file transfers are unaffected by this Overhead
- FMS is the same in 2-Tier and 4-Tier
Relative Amounts of Overhead – 2-Tier vs. 4-Tier

The diagram below shows relative effects of Middle Tier Drag (the Yellow Band) as measured in internal development.

For comparison – Tc2005 SR1 results

Web Tier components overhead:
HTTP (0.2%)
Web Tier Total (0.5%)
Not a big deal anymore!
Changes from Teamcenter 2005
Changes Great and Small

Infrastructure Changes
- Increased payload compression – affected both 2-Tier and 4-Tier
- Various reductions in middle tier overhead – memory and CPU – specific to 4-tier
- Improved install and administration

Application Changes to Reduce “Chattiness”
- Significant re-structuring of PSE “Expand Below”
- Many, many other improvements in various use cases
Development Internal Tests

(Large) Expand BOM Below nx2_3083c_6l (RDV88227-anne)
- APA Lab test case
- Produces a 3083-line, 5-level BOM
- 18 calls from client to server (variation observed; timing?)
- Total Payload
  - 2MB between tcserver and app server (111KB / call)
  - 100KB between app server and Portal (20/1 compression ratio)

(Small) Expand BOM Below for a subpart (TL114286)
- 337-line, 4-level BOM
- 17 calls from client to server
- Total Payload
  - 360KB between tcserver and app server (21K / call)
Comparison to 2005 SR1

![Comparison to 2005 SR1](image)

- **Portal**
- **HTTP**
- **Web Tier**
- **CORBA**
- **TcServer**
Internal Test Summary

Huge improvement due to reduction in call count from 467 to 18
- Reduces the accumulation of web tier overhead

Significant improvements due to reductions in web tier latency per call
Teamcenter 2007.1 Performance
APA Lab Testing

Established Schedule, Methodology, Dedicated Team and Hardware Performed for Thin Client, Rich Client, CAD Integrations
Results reported here are a simplified subset
- Latency is introduced artificially
- T1 Bandwidth
- FMS Client Cache empty – partial or full cache can vastly reduce file retrieval times
- Optional FMS WAN Acceleration not enabled – this can benefit higher levels of latency
- File transfer bandwidth effects can be very high – sometimes a bigger effect than latency on file transfer
More Cautions

These results were chosen to be representative – not definitive. The absolute numbers (which vary by use case and Teamcenter version) mean less than the basic trends – the trend lines shown are typical of most use cases:

- 4 Tier performs better when any significant latency exists – even low levels ~ 5 milliseconds.
- As latency increases response time degrades:
  - In a linear manner – no “tipping point”
  - In a shallow slope – doubling latency does NOT double response time.
Tc 2007.1 Rich Client
Single User WAN Performance -

4-Tier more efficient than 2-Tier at higher latencies (shallower slope)
4-Tier improved 32% across average of use cases between Tc 2005 SR1 and Tc 2007.1 (UA)
32% overall improvement
WAN response time very predictable and aggregate is linear with latency
Slope of latency affect has improved with Tc2007.1
Tc 2007.1 4-tier Rich Client WAN performance at T1/200ms now at 5.5x
LAN performance
  - Better than Tc 2005 at T1/120ms of 5.8x
Significant improvements to PSE “Expand Below”
APA LAN/WAN Rich Client Averaged Results - Teamcenter 2005 SR1 vs Teamcenter 2007.1

Teamcenter 2005 SR1
2-tier Rich Client
- Not recommended with more than 5 ms latency
4-tier Rich Client
- 5.8x response time with 120ms latency
- 8.1x response time with 200ms latency
- Considered usable at 120 ms latency
4-tier Thin Client
- Considered usable up to 400ms latency

Teamcenter 2007.1 (unified)
2-tier Rich Client
- Not recommended with more than 5 ms latency
4-tier Rich Client
- 4.1x response time with 120ms latency
- 5.5x response time with 200ms latency
- Considered usable at 200 ms latency
4-tier Thin Client
- Considered usable up to 400ms latency
APA Performance Environment

Teamcenter 2007.1 (unified architecture) 4-tier performance is much improved
Reminder

These results were chosen to be representative – not definitive
The absolute numbers (which vary by use case and Teamcenter version) mean less than the basic trends – the trend lines shown are typical of most use cases

- 4 Tier performs better when any significant latency exists – even low levels ~ 4 milliseconds
- As latency increases response time degrades
  - In a linear manner – no “tipping point”
  - In a shallow slope – doubling latency does NOT double response time
    - Slope is shallower in more recent releases
- **Benchmarking with your use cases in your environment is very important in determining acceptability**
Measurements from a development lab using a Network Nightmare box to simulate latency.

Load tests run on 10 different assemblies of various sizes and complexities,
- Each load was run three times
  - Load from scratch, close, load again, close, load again
- Each data point presented is an average of all the load data
Teamcenter Integration for NX
Test Results – Full Load / Elapsed Time

NX 5.0.4 outperforms 2-tier starting at latencies of 10ms to 15ms
(Elapsed Time Comparison for Assembly Load, FCC cache full)
Teamcenter Integration for NX
Test Results – Full Load / Response Delta

NX 5.04 4-Tier more efficient than NX 5.03 4-Tier at all latencies
(Assembly Load, FCC cache full)

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Performance comparison between a baseline version and the latest versions of Teamcenter and the Teamcenter Integration for CATIA (TcIC)

- Baseline version: Teamcenter Engineering 2005SR1 with TcIC V6.7.1
- Latest version: Teamcenter 2007.1.2 (unified architecture) with TcIC V7.0.1

Expected Results

- Partial Load Performance
  - V7.0 contains new algorithms for partial load scenarios that should improve performance dramatically
- 4-Tier WAN Load Performance
  - V7.0 contains a new method for acquiring access to files in a volume, which should improve load performance over a WAN
- Save Performance
  - Save performance should be the same
Test Results – Partial Load

TcIC Partial Load Performance Comparison

Order of magnitude improvement in V7.0 vs. 6.7.1

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Test Results – V7.0.1 WAN vs. LAN (Large Assembly Load)

Almost no performance degradation as latency increases, except when CAD files have to be moved across the WAN (FCC cache and staging directory empty)
Modest performance degradation as latency increases, except when CAD files have to be moved across the WAN (FCC cache and staging directory empty).
CATIA Conclusions

Compared with TcIC V6.7.1 with TcEng2005 SR1, the latest versions, TcIC V7.0.1 and Teamcenter 2007.1.2 (unified architecture):

- Show dramatic improvement in partial load performance
- Show significant improvement in performance of other load scenarios
- Show the same performance for Save

These latest versions show only modest performance degradation in WAN environments as latency increases, except when CAD files need to be copied over the WAN. This configuration meets the Teamcenter 2007.1 performance requirements for WAN latency of 200ms.
Teamcenter Integration for Pro/E (IPEM)

- IPEM 5.7 was delivered in Dec, 2006 providing 4 tier performance up to 60 ms
- Teamcenter SOA was delivered in similar timeframe allowing the technical framework to achieve higher performance latency goals
- Development committed to improve the IPEM 4 tier performance to align with the Teamcenter ‘s rich client
- Goals have been achieved and delivered in Dec, 2007 with IPEM 7.0 release
  - IPEM 7.0 has eliminated the latency constraint associated with metadata
  - Teamcenter provides solution for file delivery and deployment flexibility to manage the file bandwidth constraints
- Future Teamcenter (unified architecture) releases will continue to improve performance of SOA and FMS (which directly improves IPEM performance)
  - Future IPEM releases will continue to evaluate techniques to take maximum advantage of Teamcenter’s services and evaluate techniques to further compress the overall wall clock performance
IPEM 7.0 Results

- Wall clock performance normalized for metadata operations
- File transfer performance scales based on Windows TCP/IP 64KB packet size divided by latency
- Demonstrates that IPEM 7.0 outperforms prior release at all latency measurements
Forward Look
More Changes Great and Small – Teamcenter 8+

Continued application and framework changes to reduce “chattiness”

- Significant re-structuring of RAC kernel to reduce call count
- Many, many other improvements in various use cases to reduce call count and utilize cache

Infrastructure Changes

- “Store and Forward” file saves in FMS
- New Firewall Friendly “Pull” Install
- Perhaps – web tier streaming?
  - Take more advantage of multiple CPU machines
Teamcenter Goals

Teamcenter (unified architecture) will be usable at:
- 120 millisecond latency in Teamcenter Engineering 2005 and 2007
- 200 millisecond latency in Teamcenter 2007 (unified architecture)
- 300 millisecond latency in Teamcenter 8 (unified architecture) and beyond

As measured by Teamcenter’s APA lab using results averaged across standard benchmark tests
- Assumes 5x degradation between WAN and zero latency LAN is still “usable”
- Assumes T1 quality bandwidth on WAN
Summary
Summary

Four-tier deployments are slightly slower than two-tier when deployed on very fast Local Area Network

- Difference is almost negligible now and may disappear or reverse in future releases
  - Numbers of CPUs in client vs. web tier machine may become significant difference in future
- LAN must indeed be “very” fast to show 2 Tier’s advantage

Four-tier deployments are superior to two-tier when almost any latency exists

Benchmarking with your use cases in your environment is very important in determining acceptability
Contact

Steve Chesney  
Software Engineer - Consultant  
Siemens PLM Software Inc.

E-mail: steven.chesney@siemens.com

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