

TIPS – A System for Contextual Prioritization of Tactical Messages

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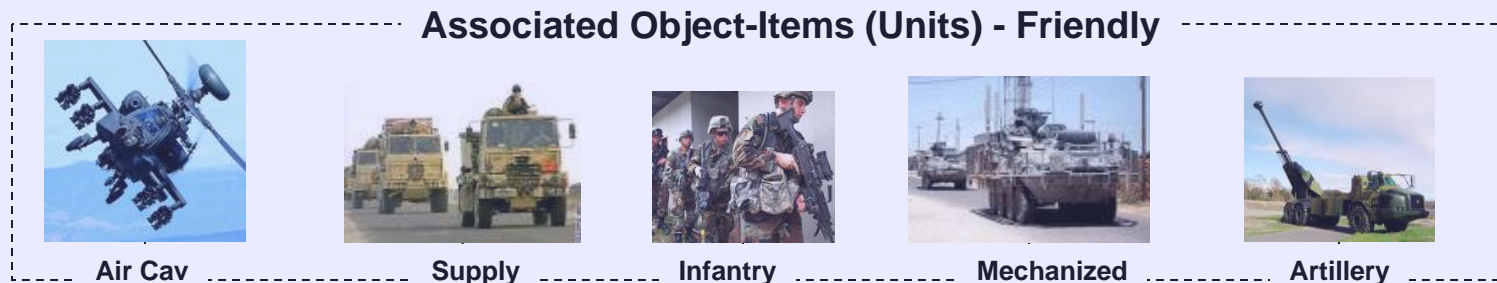
What is Tactical Information Processing Systems (TIPS)?

- TIPS is an automated decision aid that will assess the applicability of a generic Reported Data Item (RDI) to a Unit of interest (UOI)
- Constrains:
 - RDI is inserted into a JC3IEDM database
 - No prior knowledge or assumptions about either the nature of the unit or the report is required
 - Provide a numerical assessment of the likelihood that the RDI should be forwarded to the UOI
- Motivation:
 - Ensure military units are supplied with the right information as conditions [rapidly] change within the Battlespace

Joint Consultation C2 Information Exchange Data Model (JC3IEDM)

- We have selected the JC3IEDM as the schema for our context assessment experiments
- Why JC3IEDM?
 - Emerging NATO standard
 - Well documented
 - Extremely comprehensive -- Designed to describe all objects within the [land] battlespace
 - Object-items (organizations, individuals, facilities, resources) and their attributes (status, capabilities, tasks, etc)
 - Information: requests, policies, ROEs, assessments
 - Captures relationships between entities
 - Has hooks for relating reported data to all manner of battlespace entities and relationships

Contextual Linkage Example



CONTEXT
Changes with Time



Action Task Objective

Definition of an Action Task forms a context between all object items involved in the action

Associated Units - Hostile
Candidate Target List



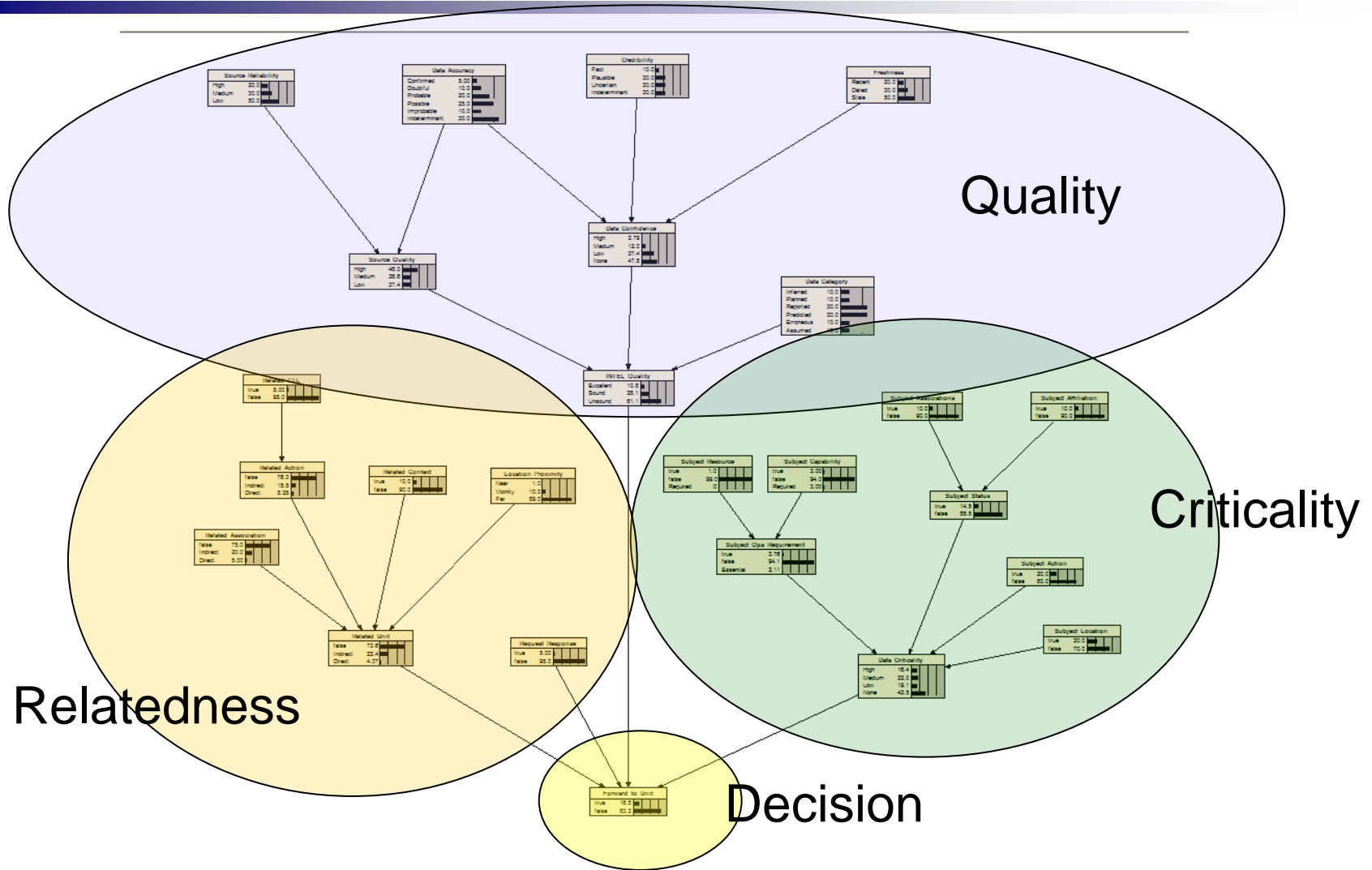
TIPS – General Approach

- Develop generic tests for contextual linkages between a given reported data item and unit with a JC3IEDM DB
- The data required for each linkage test will be extracted through SQL queries
 - Each test exercises a unique path within the JC3IEDM schema to search for indications that the report is relevant to the unit
 - Multiple linkages may exist
- Once the linkage test is run, the resulting findings will be inserted as evidence into a Bayesian Network
 - Network purpose is to make a probabilistic assessment whether or not to forward the report to the unit in question
 - PDF functions within the BN can be adjusted as necessary—consistent with the Information Staff's belief in the contribution of each factor to the decision to forward the report
- In this model, the forwarding probability for the report is an analog for its transmission priority

TIPS Bayesian Network (BN) Query Approach

- Assess the Report's Quality:
 - Based on factors such as source, credibility, and freshness
 - These differ based on the type of report. For example: SITREPS come from trusted sources; INTEL reports may not
- Assess Report Criticality:
 - Criticality is based on mix of subjects addressed in report
 - Perform queries to determine the subject themes addressed by each RDI (see mapping of Tables to Subject Nodes)
- Assess Relatedness to the Unit of Interest:
 - Compile list of object-items referenced in the RDI
 - Perform queries to determine if these items are associated with the UOI
 - Determine the strength/importance of these associations
 - Other factors: Time, Location, and Organizational

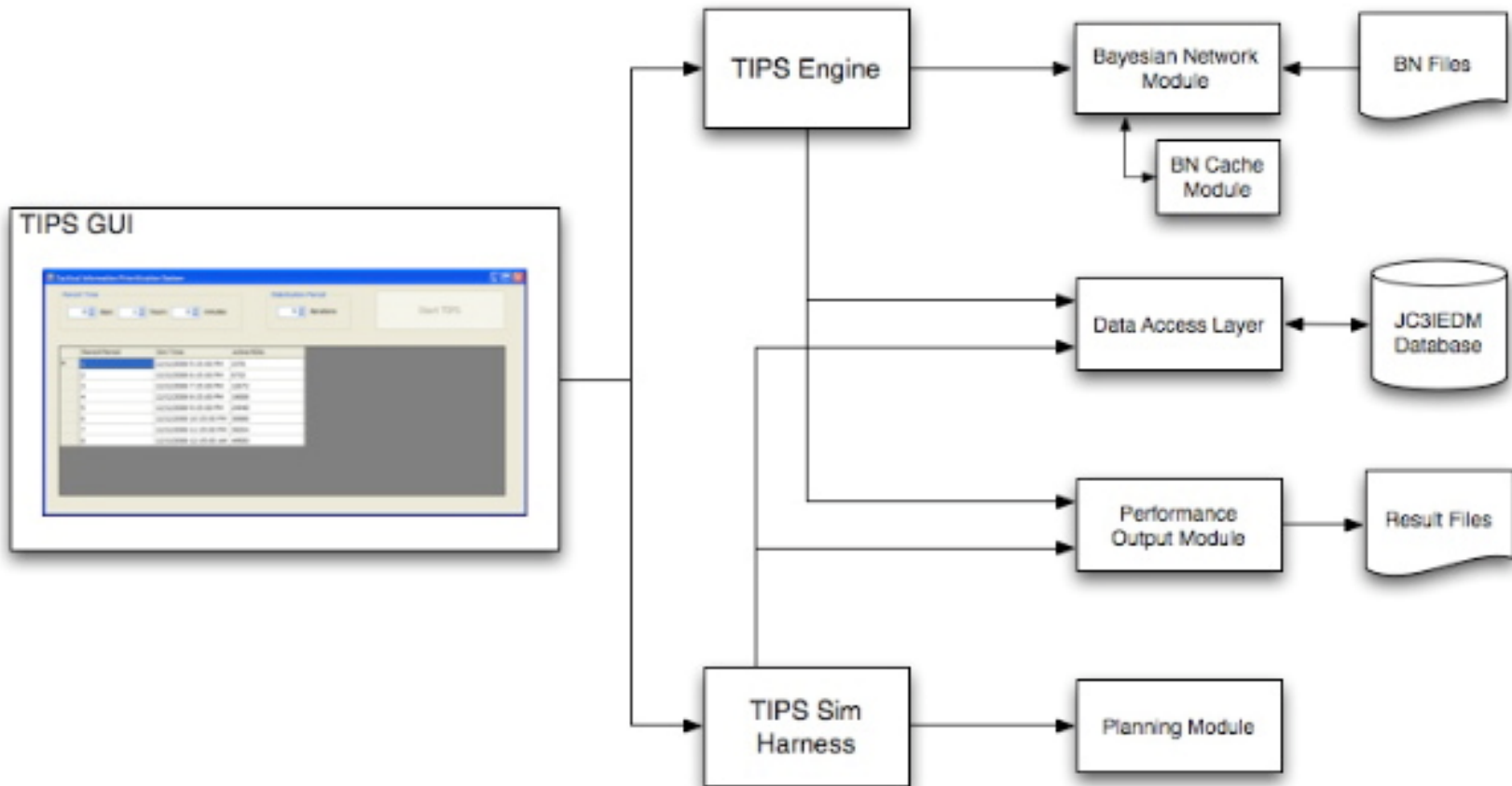
TIPS BN Structure



Mapping of Table Entries to BN Subject Nodes

Table	BN Subjects
Action-Event	Action
Action-Event-Detail	Action
Action-Event-Status	Action, Status
Action-Location	Action, Location
Action-Task-Status	Action, Status
Object-Item-Affiliation**	Affiliation → Status
Object-Item-Association-Status	Association → Status
Object-Item-Capability	Capability → Ops-Requirement
Object-Item-Hostility-Status	Affiliation → Status
Object-Item-Location	Location
Object-Item-Status	Status
Organisation-Structure	Association → Status
Holding	Resource → Ops-Requirement
Target-Personnel-Protection	Resource → Ops-Requirement, Action

TIPS Architecture





TIPS Performance Data

Scenario Message Priority Differences (TIPS vs. Human Analysts)

Comparison Type	Statistic			
	Raw Assignments		Normalized* Assignments	
	(μ)	(σ)	(μ)	(σ)
TIPS vs. Intended	14.03	9.41	4.64	6.44
TIPS vs. Analysts-All	11.81	8.05	2.91	4.75
TIPS vs. Analysts-Expert	19.97	15.30	9.50	13.54
TIPS vs. Consensus-All	11.06	6.70	1.98	3.38
TIPS vs. Consensus-Expert	14.90	9.86	5.16	7.09

Priority Scale:	Score
No Relationship	0
Very Low	12.5
Low	25
Medium Low	37.5
Medium	50
Medium High	62.5
High	75
Very High	87.5
Absolute	100

*Normalized – Considered equivalent if within ± 12.5 of each other

TIPS Changes – Performance Parameters

- Implemented “Revisit Period” and “Stabilization Period” parameters

Parameter	Definition
Revisit Period	The length of time between TIPS examination of messages for a given unit
Stabilization period	The number of revisit periods that must pass without a change in TIPS score before a RDI is no longer considered for transmission to a given unit. <ul style="list-style-type: none">▪ Stabilization is determined for each RDI/Unit pairing

TIPS Performance Metrics

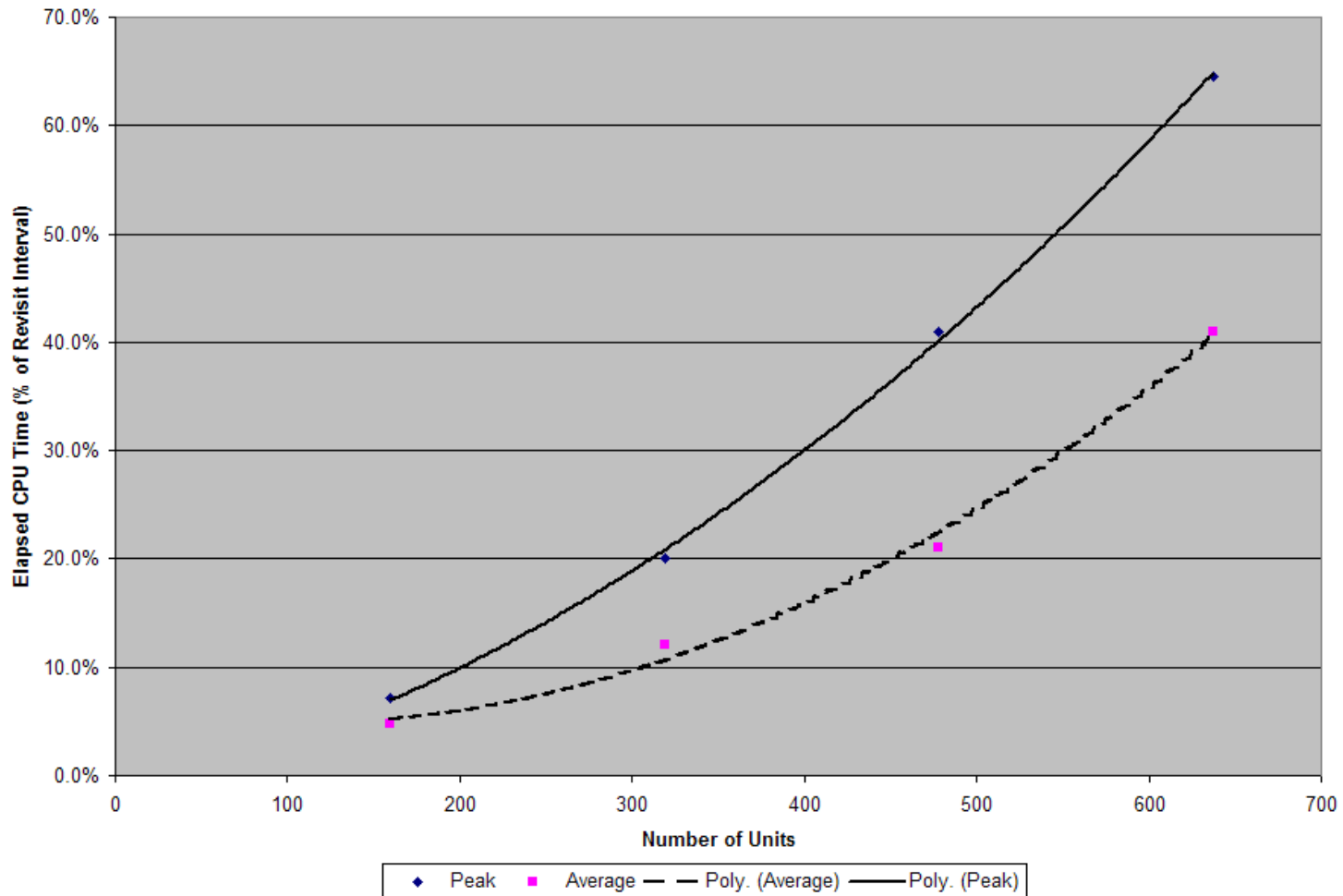
Metric	Definition
Scenario	
Scenario Time	Time elapsed since start of the scenario
Number of units	Total and by type (e.g., battalion)
Unit Utilization (%)	The % of scenario time a given unit is tasked. [TSH]
Message Histogram	Histogram (by message type) showing the relative frequency of message generation (by each unit) during the scenario. Histogram is cumulative and updated every revisit period.
Database Size	
Num RDIs	Number of Reported Data Items (RDIs) inserted into the JC3IEDM DB instance by the TSH since the start of the scenario
Num Linkages	Number of RDI-related linkages inserted into the JC3IEDM DB instance.
Num DB Entries	The total number of JC3IEDM table entries at a given point in the scenario.

TIPS Performance Metrics (cont.)

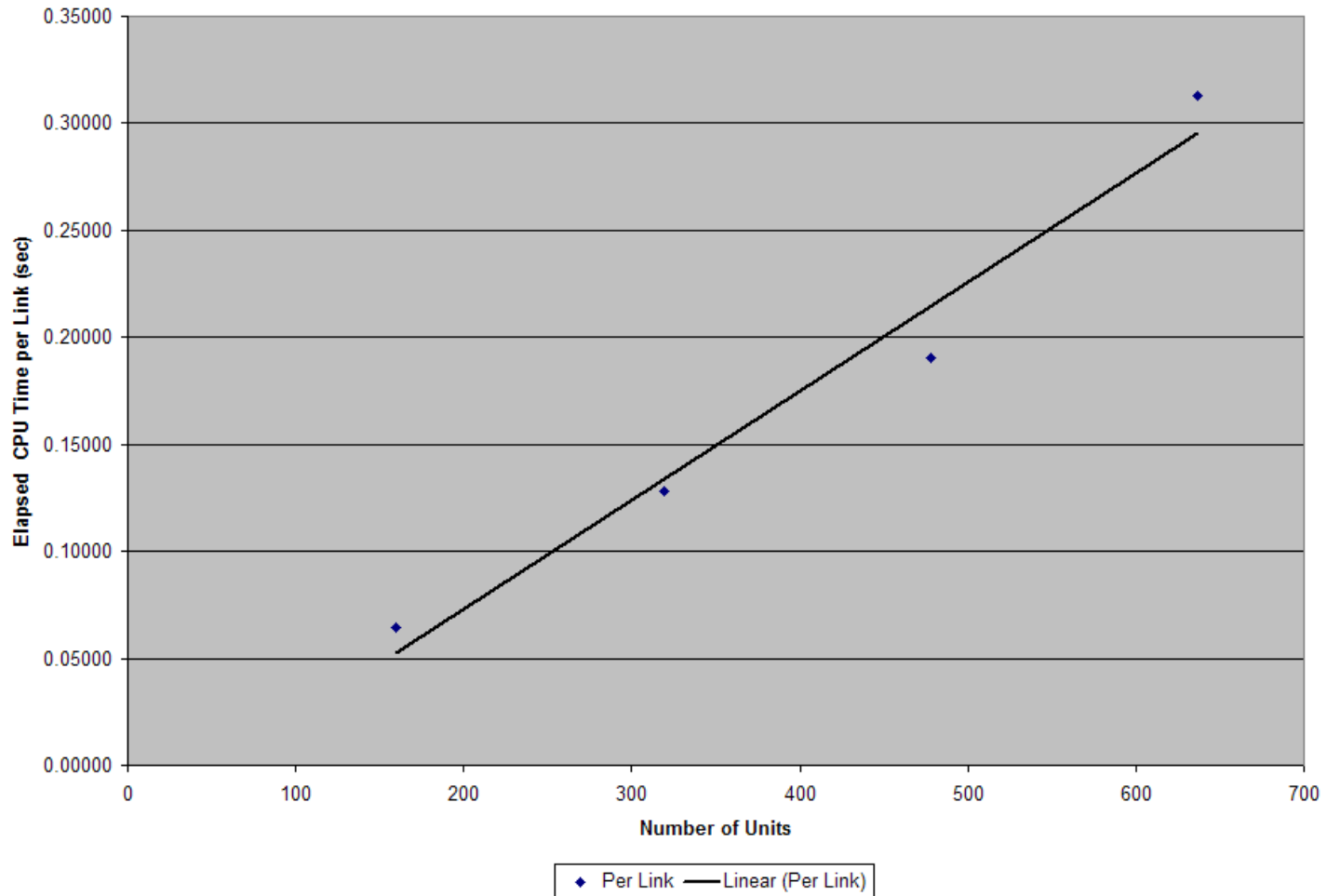
TIPS Runtime

Category	Definition
RDI/Unit Pairs	<p>The total number of TIPS queries performed per RDI. We track two items in this category:</p> <ul style="list-style-type: none">• Active – still being evaluated• Stabilized – evaluation has ceased
Elapsed TIPS CPU time (per revisit period)	<p>The amount of elapsed CPU time to execute all TIPS queries during a given revisit period. Metrics in this category:</p> <ul style="list-style-type: none">▪ Total elapsed time (over all units)▪ Average elapsed time (per friendly units only)▪ Average elapsed time (per number of linkages)▪ Average elapsed time (per active RDI)
RDI score change	<p>The difference in the TIPS BN score for a given RDI. The difference is computed using the average score for the first revisit period (when the RDI becomes active) and the last (when it becomes inactive). The MEAN and STDEV statistics are computed for this metric.</p>
RDI time active	<p>The average number of revisit periods that an RDI is active. This is computed over all RDIs each revisit period. The MEAN and STDEV statistics are computed for this metric.</p>

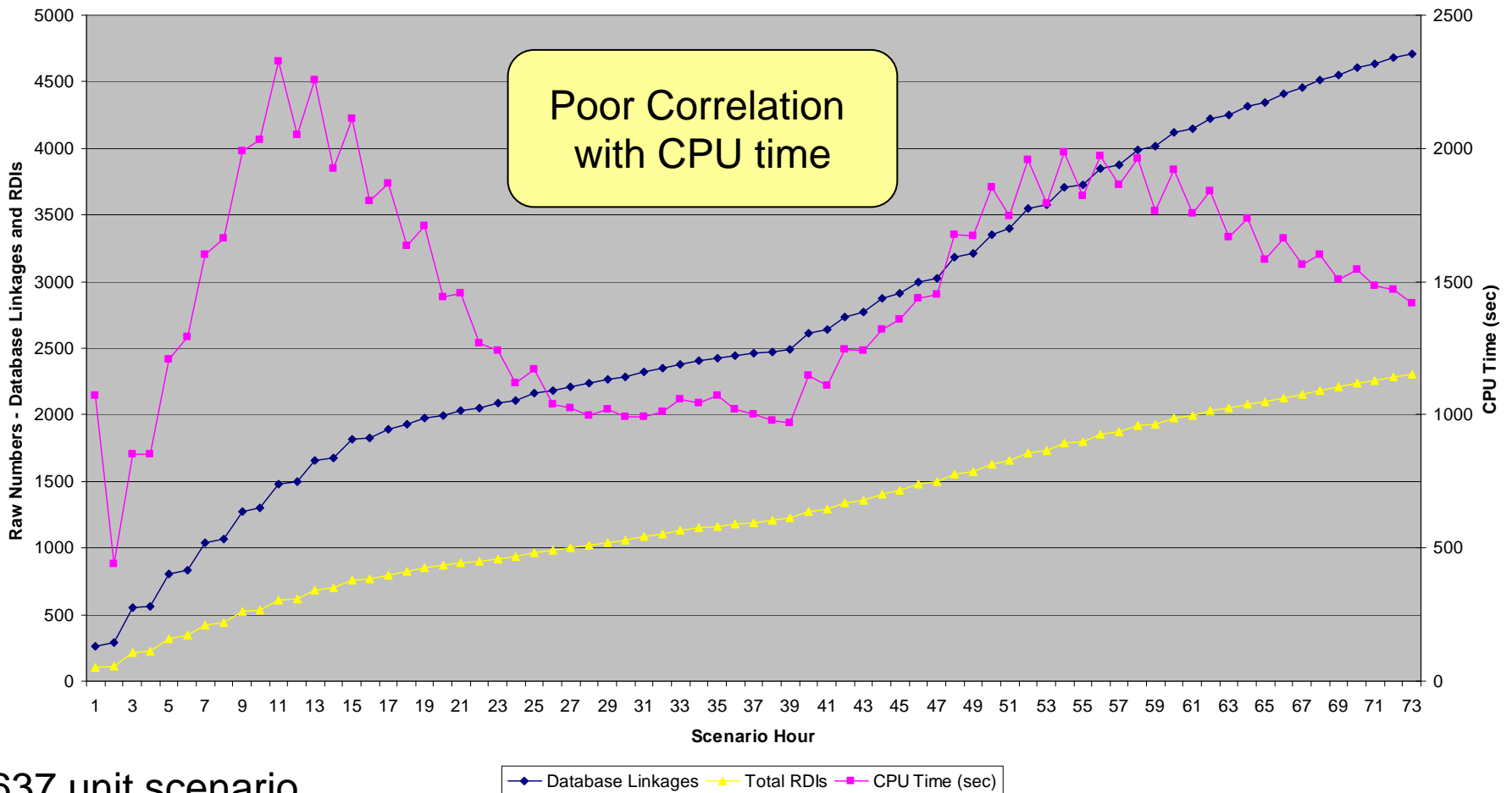
TIPS CPU Utilization as a function of Friendly Units (Inter-Scenario)



TIPS CPU Utilization as a function of Database Linkages (Inter-Scenario)

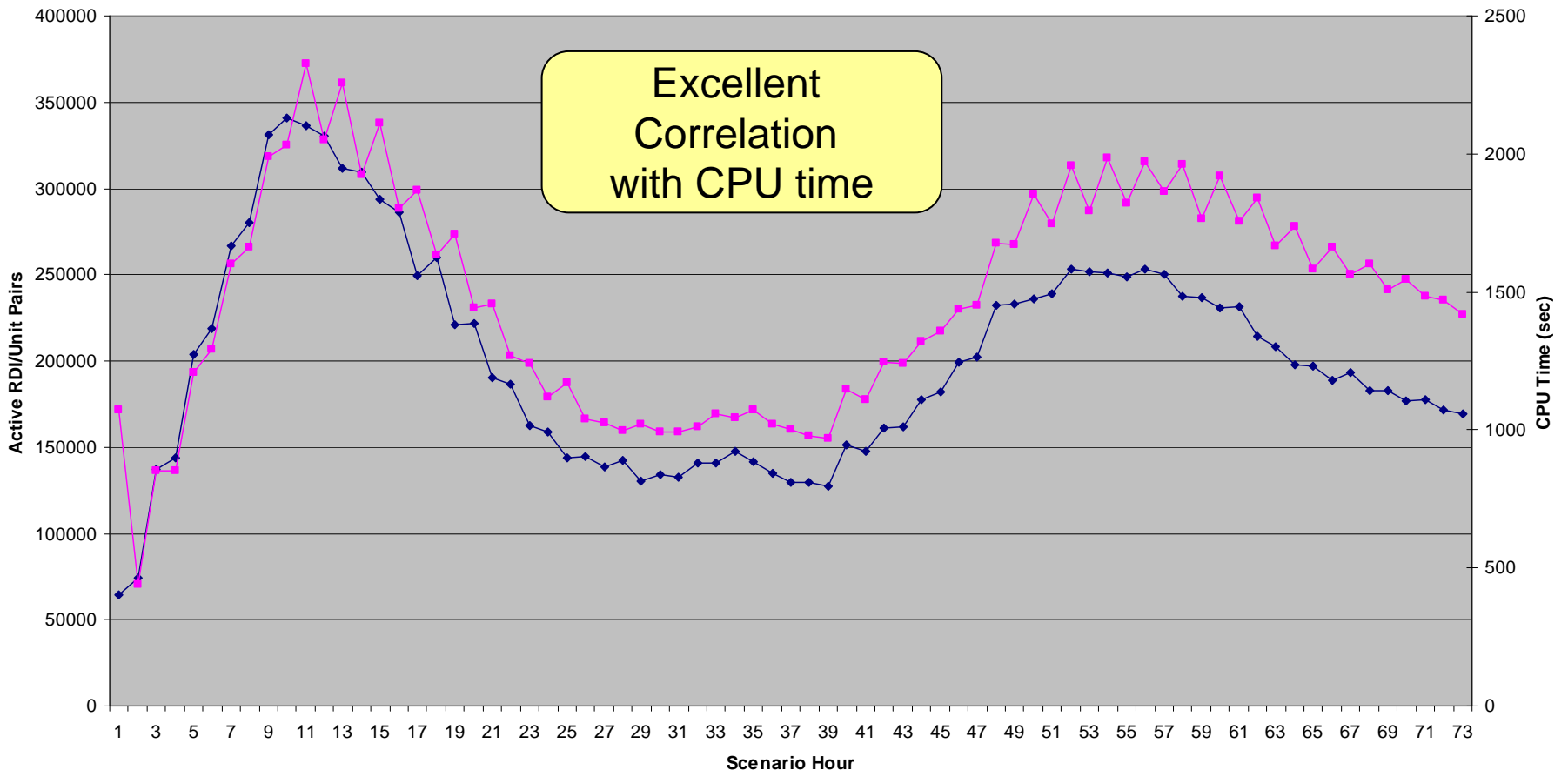


CPU Utilization vs. Database Linkages and RDIs (Intra-Scenario)



637 unit scenario

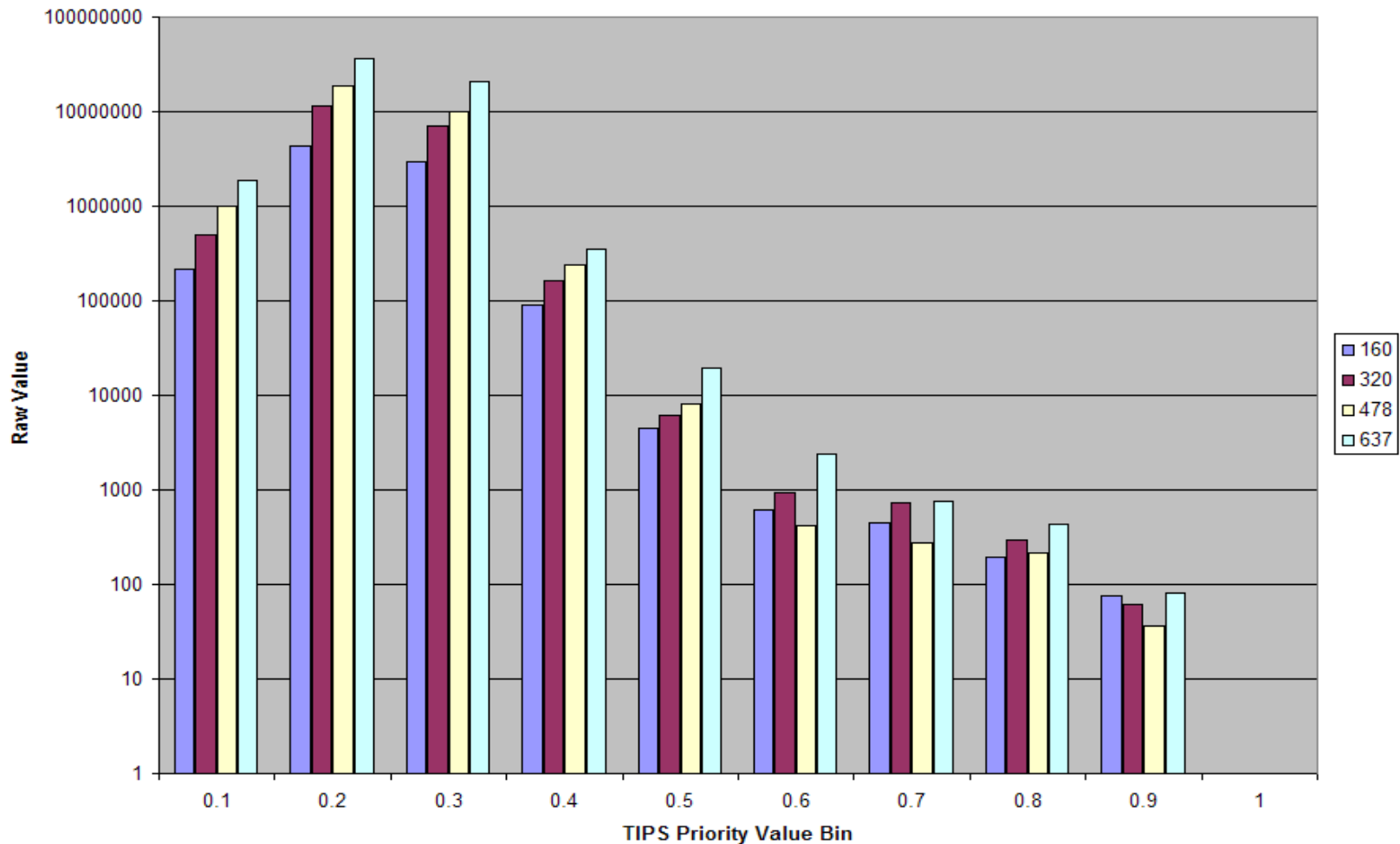
CPU Utilization vs. Active RDI/Unit Pairs (Intra-Scenario)



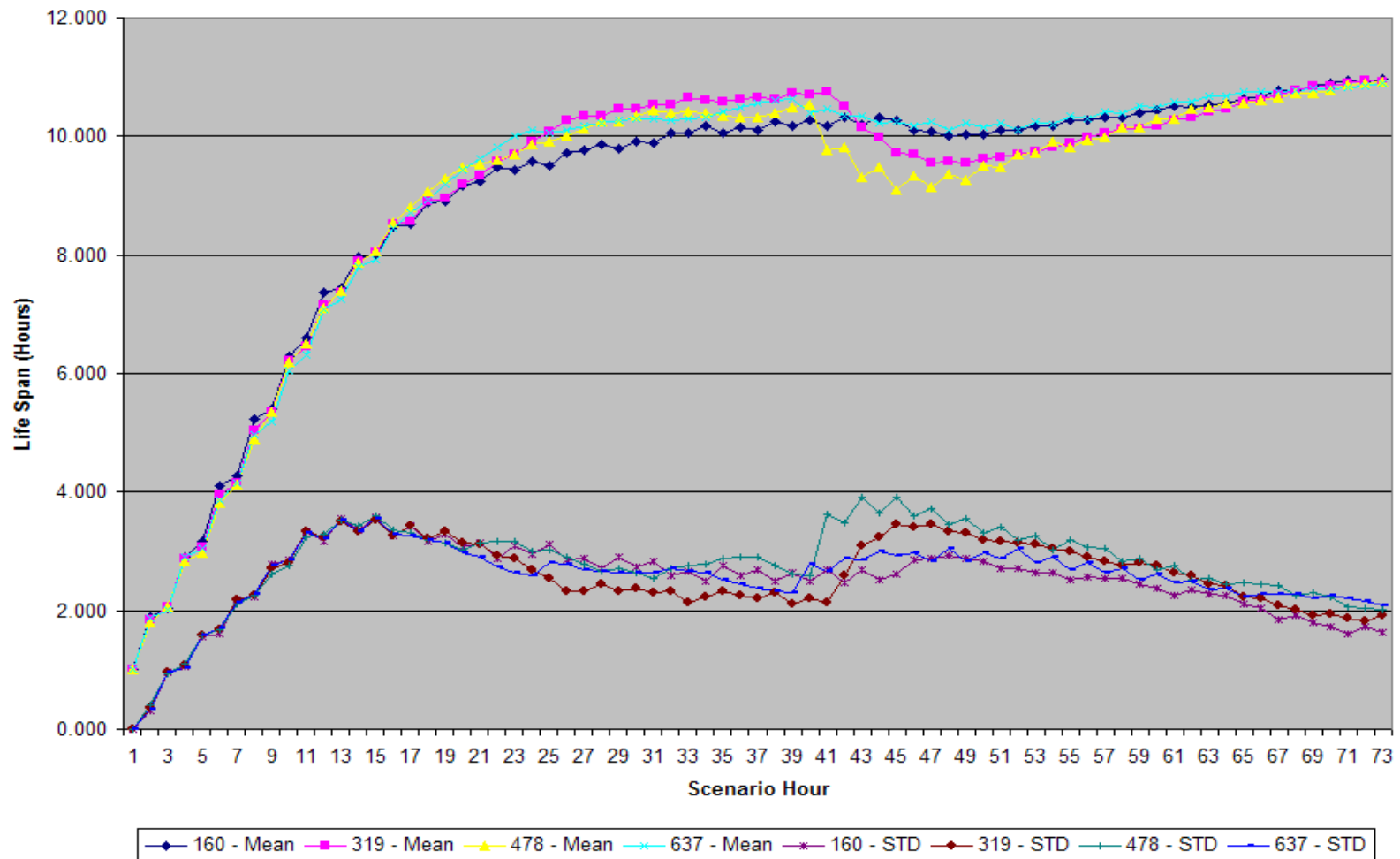
637 unit scenario

Active RDI/Units CPU Time (Sec)

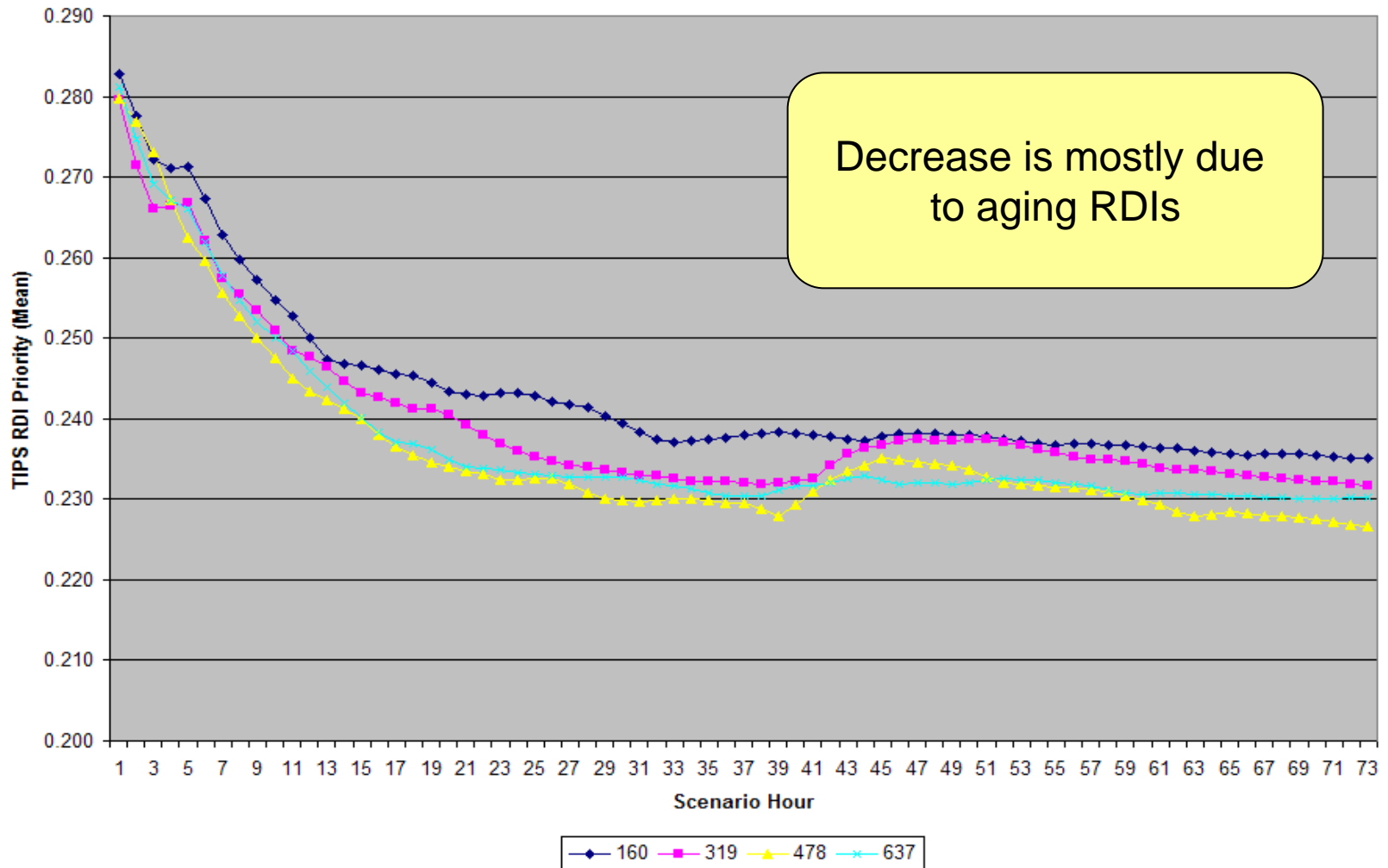
Distribution of TIPS Generated Priorities (Inter-Scenario)



RDI Time Active



TIPS Mean RDI Priority



Summary

- The automatic extraction and interpretation of context can be an extremely useful technique for maintaining situational awareness in complex, dynamic environments
- TIPS performs contextual mining of JC3IEDM databases to prioritize tactical reports for transmission to specific units
 - Richness of JC3IEDM schema is key to the TIPS approach
 - Emphasis is on: Report Quality, Criticality, and Relatedness to Unit
- Our results have shown that the runtime performance of the TIPS architecture scales linearly as the scenario message traffic increases
- TIPS assessments factor in subtle relationships that may elude human C2 operators—thereby improving the situational awareness of military units in the Battlespace

Questions?

