



# Laboratory-to-Field Transition Of the Policy Analysis Market

Deliverable #2 to DARPA of  
Contract #DAAH01-02-P-R064

13 December 2002

# Promise -- Clearer View of an Interconnected World

U.S. security *happens* in an interconnected world.

- Developments in a country are easier to measure than connections among these developments.
- Key Question for Proactive Policy Analysis -- Given possible developments, what connections will impact U.S. security?

Markets -- A new tool to augment policy analysis?

- Insight about countries is spread diffusely.
- When markets work, they focus diffuse information into prices.

PAM -- a market designed to resolve connections from diffusely-held pieces of a puzzle.

- Defensive: Better predictions of what might happen
- Offensive: Better predictions of how to affect what might happen

# Fundamental Requirement

## Need to discern correlation among events

- Suppose the U.S. plans to attack Iraq and cares about Jordan

### Overthrown of Hashemites

	A	$\sim A$	Price
Iraqi Regime persists after One Month of Open Hostilities	AB 0.30	$\sim AB$ 0.20	\$0.50
	A $\sim B$ 0.05	$\sim A\sim B$ 0.45	\$0.50
Price	\$0.35	\$0.65	

- Just knowing  $P[A] = 35\%$  may not affect Iraq-attack plans.
- Knowing  $P[AB] = 30\%$  may cause the U.S. to plan a quick kill.

## Principal PAM Hypothesis: Let traders *hedge*

- Use orders of the form *This if That* to reveal  $P[A|B] = 60\%$

# Unavoidable Complications

Useful time horizon makes enumeration of specific events-of-interest intractable & impossible.

- Proactive policy analysis requires a lead time of one or more years.
- If you could name all the future events you might care about, the market would be a computational nightmare and hopelessly *thin*.
- If you could name all the future events you might care about, you would be prescient and not need any policy analysis tools.

Policy analysis is ongoing -- no end date for PAM

- Assets that represent events must payoff if their prices are to indicate the probability of something that has or has not happened.
- New assets must be issued into PAM to keep the time horizon usefully distant.

# Phase I Accomplishments: Market Mechanisms

## Combinatorial mechanisms -- composite asset trading

- Joint events, and hedges on them, are in terms of composite assets

## Combined Value Call Market (CVC)

- Orders submitted and accumulate until the market is *called*
- Multilateral trades identified
- Not specifically designed for PAM case, but appeared modifiable

## Automated Combinatorial Market Maker (MM)

- All trades are through a software intermediary, the MM
- MM trades subject to fixed reaction functions, requiring subsidization
- Specifically designed for PAM case, but never before deployed

Phase I Status: Component tested and modes of use considered

# Phase I Accomplishments: Asset Structure

Identify assets that track course of events in a country

- Domestic: economy, civil stability, military posture
- International: U.S. economic and military involvement

Include assets that track U.S. concerns (Econ. & Casualty)

Give each asset a fairly long life (e.g., 1 or 2 years) and issue new sets frequently (e.g., quarterly)

Intent: Trading will identify events-of-interest not foreseeable when the assets were issued.

As specific events are identified, add short-term assets

EIU identified to build, maintain, and judge assets.

# Transition Effort to prepare for Phase II

Integration of Market Mechanisms

Data Series & Asset Process Development

Production User Interface Design

Field Test Implementation Plan

# Mechanism Integration: Overview

## Stylized Environment

- Construct a situation with known correlated information properties
- Control the views that human subjects have of this situation
- Use abstract and simple terms to avoid bias

## Common Order Formation & Interface

- Comparison of MM and CVC requires a common *playing field*.
- If both are to be used in the same product, commonality is a must.

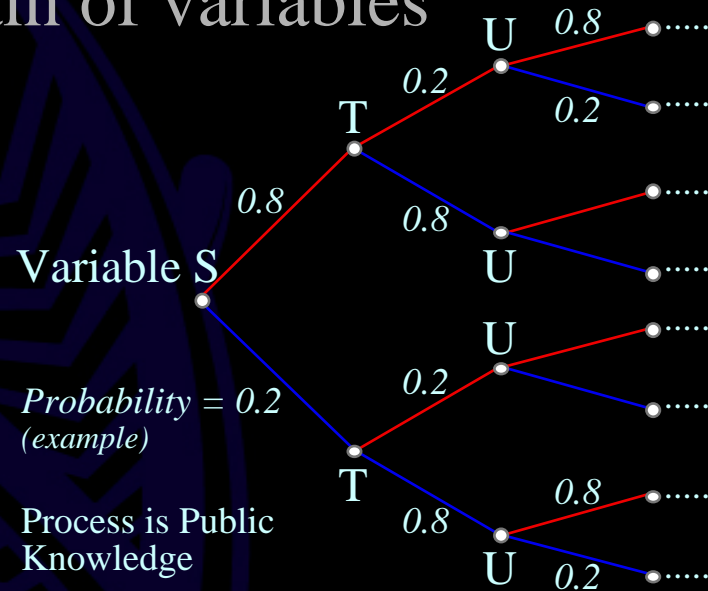
## Outcomes

- MM and CVC are better than Standard Simultaneous Markets (SS).
- PAM version 1.0 will debut as MM-only.

# Mechanism Integration: Environment

## Basic Environment -- chain of variables

- Readily Explainable
- Fairly fast to run
- No context bias (neutral)
- Many variables, but
- Few are directly related



Each trader views *some* outcomes and no two traders see exactly the same information

- Rename & reorder -- XYZ to ABC and then *shuffle* (e.g., BAC)
- Give each trader information about some of the variables

# Mechanism Integration: Environment (continued)

Caltech's social science laboratory was used to run experiments using this type of environment

- MM, CVC, & SS tested
- Two hour sessions of 6 periods
- New environment *drawn* each period

## Training Session Environment

- X,Y,Z,  $2^3 = 8$  combinations
- $P(X=0) = .3$ ,  $P(X=Y) = .2$ ,  $P(Z=1) = .5$
- Random mapping of XYZ to ABC
- 3 people, see 10 cases of: AB, BC, AC
  - Mapping in this case is  $ABC = XZY$

Case	A	B	C
1	1	-	1
2	1	-	0
3	1	-	0
4	1	-	0
5	1	-	0
6	1	-	1
7	1	-	1
8	1	-	0
9	1	-	0
10	0	-	0
Sum:	9	-	3
Same	A	B	C
A	--	--	4
B	--	--	--
C	--	--	--

# Mechanism Integration: Environment (continued)

## Test Session Environment

- 8 binary variables STUVWXYZ
- $2^8 = 256$  combinations
- $.2 = P(S=0) = P(S=T) = P(T=U) = P(U=V) = \dots = P(X=Y) = P(Y=Z)$
- Random map STUVWXYZ to ABCDEFGH
- 6 people, see 10 cases of:  
ABCD, EFGH, ABEF, CDGH, ACEG, BDFH
  - Mapping here is ABCDEFGH = WVXSUZYT

Case	A	B	C	D	E	F	G	H
1	0	1	0	1	-	-	-	-
2	1	0	0	1	-	-	-	-
3	0	0	1	1	-	-	-	-
4	1	0	1	1	-	-	-	-
5	0	1	1	1	-	-	-	-
6	1	0	0	1	-	-	-	-
7	0	1	1	1	-	-	-	-
8	1	0	0	1	-	-	-	-
9	1	0	0	1	-	-	-	-
10	1	0	0	1	-	-	-	-
Sum:	6	3	4	10	-	-	-	-
Same	A	B	C	D	E	F	G	H
A	--	1	2	6	--	--	--	--
B	--	--	7	3	--	--	--	--
C	--	--	--	4	--	--	--	--
D	--	--	--	--	--	--	--	--
...								

# Mechanism Integration: Order Formation Process

## Order formation process of a trader using MM

- Step 1: See a composite asset whose price seems too high or low
- Step 2: Specify a new price
- Step 3: Observe what the impact would be on your cash and asset holdings if you execute this trade to *move the market*
- Step 4: Execute or reform the order

## Order formation process of a trader using CVC

- Step 1: Same as for MM
- Step 2: Specify a limit price and designate it as a Bid or Ask
- Step 3: Observe how large a trade you can finance at this limit price and the size of the order as a percentage of your capability
- Step 4: Submit the order and wait for the Call

# Mechanism Integration: Market Maker Interface

**Holdings by Variable Val.**

	A	B	C
200_			
180_			
160_			
140_			
120_			
100_			
80_			
60_			
40_			
20_			
0			

Money: 32.57  
Reserve: 40

**Market Information**

	Variable		
	A	B	C
Update			
Red ( 1 ) Price	0.71	0.5	0.5
Frequency	14	0	7
Conditioned On	---	--	C=0
Red ( 1 ) Price Conditional On	0.91	0.5	

**Order Function**

	Choose Security		
	A	B	C
Reset			
Value	A=1	---	---
Conditioned On	---	---	C=0
Indicated Price	0.91		Raise    Lower
Target Price	<input type="text"/>	Applicable Holdings	
Tolerance	<input type="text" value=".01"/>		32.57    150.11
		Price Limit	0.95    0.05

# Mechanism Integration: Call Market Interface

### Holdings by Variable Val

	A	B	C
Value	195	30	75

Money: 30  
Reserve: 40

### Market Information

	Variable		
	A	B	C
Update			
Red ( 1 ) Price	0.5	0.5	0.5
Frequency	2	0	2
Conditioned On	---	---	C=0
Red ( 1 ) Price Conditional On	0.5	0.5	

### Order Formation

	Choose Security				
	A	B	C	Buy	Sell
Reset					
Value	A=1	---	---		
Conditioned On	---	---	C=0		
Indicated Price	0.5				
Offer	0.6			30	195
Offer Type	Bid			Holdings And Money Committed	
				75.0	75% Used

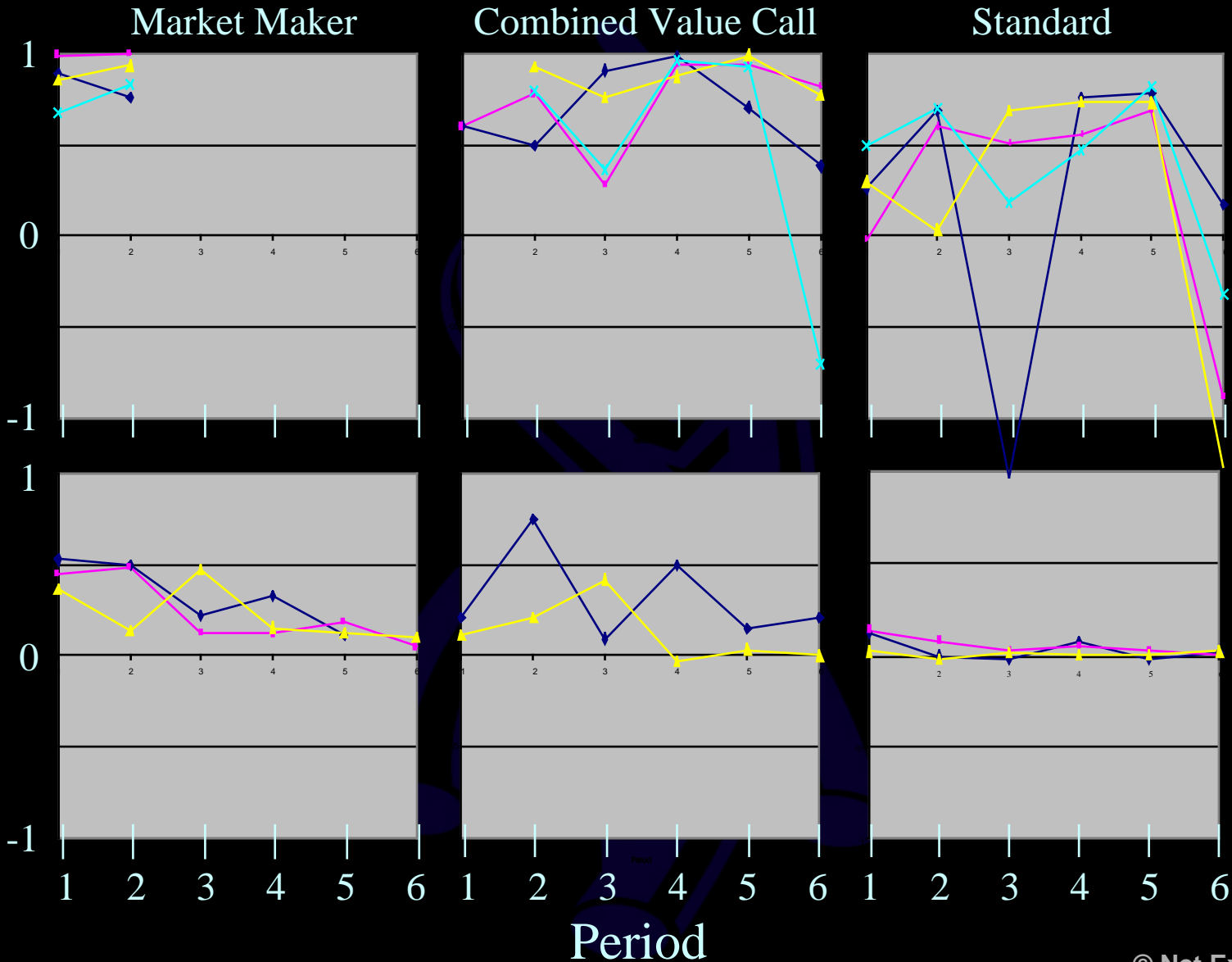
# Mechanism Integration: Data

Information

3 Var

Environment

8 Var



# Mechanism Integration: Conclusions

Combinatorial markets are superior to standard simultaneous markets

Both combinatorial mechanisms can function with the same order formation process and user interface

MM has superior *Cold Start* functionality to CVC

- Prior to any price information existing, CVC is handicapped by a trader's need to find counter-parties -- improvements possible.
- MM gets around this Cold Start problem (impact of subsidization).

Testing insufficient to pick best, but not necessary

- MM is the natural selection when PAM has very few traders.
- CVC can be improved and integrated with MM if desirable.

# Data Series and Assets

## Want seven types of assets

- For each covered country: Economic Health, Civil Stability, Military Posture, Econ. & Mil. Involvement with U.S.
- U.S. tracking assets: Economic Health, Casualties, Global Econ.

## Intended coverage impacts data availability: Middle East, Subcontinent, and Central Asia (including Caucasus)

- E.g., of the 10 data series selected for a covered country's economic health, all are available for only Israel & Turkey, and fewer than five are available for Iraq, Turkmenistan, Afghanistan, & Qatar.

## Much data requires special collection or treatment

- Tourism arrivals, resident western foreigners, arms acquisition, etc.

Assets based on indices built from available data\*

# Data Series Subcontract with EIU

The EIU has agreed, in principle, to:

- Collect quarterly data and process these into asset indices
- Serve as *Judge* of the quarterly level of each asset
- Transparent process supervised by an Advisory Panel

Included in the subcontract would be

- Four quarters of historical data leading up to the start of trading
- Judge of Specific Event Securities issued into the near-term market
- Several scopes of coverage bid
  - Core Group: Israel, Turkey, Egypt, Jordan, Kuwait, Lebanon, Saudi Arabia, Bahrain, Yemen, Iran, Qatar, Syria, UAE, Oman, Iraq
  - Core plus Subcontinent and/or Central Asia
  - Per country

# Production User Interface

Map-based with all functions accessed from one screen

Heavy use of data tabs &  
in-country pop-ups

Sort market-wide data by

Country, Date

Issue/asset

Examine holdings by:

Trade history

Composite Asset

Access User Support

Transfer funds

Nominate event assets



# Field Test Implementation Plan: Overview

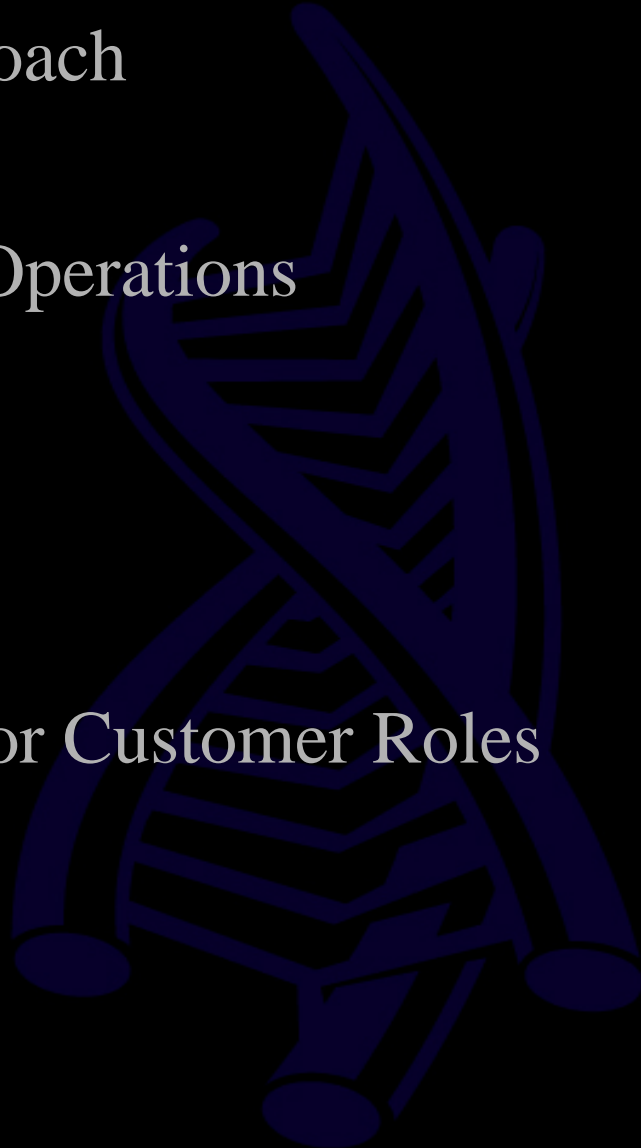
Product Approach

Technical & Operations

Participation

DARPA and/or Customer Roles

Cost



# Field Test Implementation Plan: Product Approach

PAM will be built and deployed as a prototype-in-test

- Version 1.0 will be deployed 6 months after the start of funding
- Version 1.0 will be of modest scope with a minimal feature set
- Each quarter, a revised and enhanced version will be released
- A development and test effort will run concurrently

## Scope of Version 1.0

- Country Coverage: core or sub-core group
- Market Mechanism: MM-only
- Interface: Map-based with basic set of portfolio analysis tools

Concurrent Development Effort will focus on mechanism and usability improvements.

# Field Test Implementation Plan: Tech. & Ops.

PAM will operate 24/7

The user application will be a Java Applet

The PAM application server will be remotely hosted

- Superior utility, maintenance, and Internet services
- Net Exchange will own and retain sole access to server

System will be sized for 1,000 users initially with identified upgrades to 10,000 users

Funds will be held in escrow and handled by agent

- Net Exchange will direct transfers through an audited process
- Likely agent is Wells Fargo Escrow

# Field Test Implementation Plan: Participation

## Non-government participation only

- Concerns over public/private & interagency money transfers

## Sponsored Participants -- individuals assigned by

- Academic & Research Institutions
- The Press and other Private Firms

## Independent Participants -- individuals who qualify as *expert investors* or sufficiently wealthy

Marketing will begin 2 months after start of funding.

Training will begin 4 months after start of funding using a beta of PAM version 1.0.

# Field Test Impl. Plan: DARPA & Customer Roles

Statement that PAM is a sponsored prototyping of a potential national security decision support tool

- Legal cover regarding securities trading concerns
- Liability cover that will form the basis of the PAM user agreement

Internal policies allowing some staff to participate as sponsored or expert

Marketing Support

Review Board

- Monitor operations and advise on improvements
- Select, supervise, and pay for any required external audit

# Field Test Implementation Plan: Cost

Cost of two-year Core-Group PAM = \$1.15 million

- Front loaded: 30% in 1st Quarter, 70% in 1st Year
- EIU share of costs = 43%

A sub-Core-Group PAM with about two-thirds of the data coverage could be done for \$800 k to \$850 k.

# Summary

PAM is ready to move forward as a prototype-in-test

- Mechanism approach chosen
- Data series and processes identified
- Implementation plan established

Estimated costs do not comply with standard SBIR

Phase II guidelines

- Available scope reduction options possible but may seriously compromise appeal and functionality.