

Some useful implementation examples

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1. Core Implementation

Base Structure

```
data RealWorldAsset = RealWorldAsset {  
    assetId :: AssetId,  
    assetType :: AssetType,  
    assetValue :: Integer,  
    assetMetadata :: AssetMetadata,  
    custodialInfo :: CustodianInfo,  
    verificationData :: VerificationInfo,  
    requirementSet :: [Requirement]  
}  
  
-- Extensible asset types to accommodate any real-world asset  
data AssetType =  
    ArtPiece ArtDetails  
  | RealEstate PropertyDetails  
  | PreciousMetals MetalDetails  
  | Commodity CommodityDetails  
  | CustomAsset CustomDetails  
  
-- Requirement system that handles any type of requirement  
data Requirement = Requirement {  
    requirementType :: RequirementType,  
    description :: Text,
```

```

validationMethod :: ValidationMethod,
verificationFrequency :: Frequency,
requirementStatus :: RequirementStatus,
lastVerified :: Maybe POSIXTime
}

```

```

data RequirementType =

```

```

    Legal
  | Physical
  | Operational
  | Environmental
  | Financial
  | Custom Text

```

Agora Governance Integration

```

data AgoraPhase =

```

```

    LockPhase LockPhaseInfo
  | VotingPhase VotingPhaseInfo
  | ExecutionPhase ExecutionPhaseInfo

```

```

data GovernanceConfig = GovernanceConfig {

```

```

    thresholds :: AgoraThresholds,
    phaseDurations :: PhaseDurations,
    votingPowerStrategy :: VotingStrategy,
    effectValidators :: Map EffectType EffectValidator

```

```

}

```

```

data AgoraThresholds = AgoraThresholds {

```

```

    creation :: Percentage,  -- e.g., 5%
    start :: Percentage,    -- e.g., 10%
    vote :: Percentage,     -- e.g., 15%
    execution :: Percentage, -- e.g., 51%
    cosigning :: Percentage  -- e.g., 25%

```

```

}

```

```

data PhaseDurations = PhaseDurations {

```

```

    lockPhaseDuration :: POSIXTime,
    votingPhaseDuration :: POSIXTime,
    executionPhaseDuration :: POSIXTime

```

```
}
```

2. Asset Journey Examples

Example 1: Fine Art Tokenization

```
-- Picasso painting tokenization example
artExample :: RealWorldAsset
artExample = RealWorldAsset {
  assetId = "art_001",
  assetType = ArtPiece {
    artist = "Pablo Picasso",
    title = "Example Painting",
    year = 1937,
    medium = "Oil on canvas",
    dimensions = Dimensions 349.3 776.6,
    authenticity = [Certificate1, Certificate2]
  },
  assetValue = 10_000_000_000_000, -- 10M ADA
  requirementSet = [
    Requirement {
      requirementType = Physical,
      description = "Temperature control 20-22°C",
      validationMethod = TemperatureSensorValidation,
      verificationFrequency = Hourly,
      requirementStatus = Active
    },
    Requirement {
      requirementType = Legal,
      description = "Insurance coverage",
      validationMethod = InsuranceDocValidation,
      verificationFrequency = Monthly,
      requirementStatus = Active
    }
  ]
}

-- Art-specific proposal example
proposeMoveToNewGallery :: ProposalParams
proposeMoveToNewGallery = ProposalParams {
```

```

description = "Move artwork to Modern Gallery",
effect = PhysicalLocationChange {
  newLocation = "Modern Gallery, NY",
  transportMethod = "Specialized Art Transport",
  insuranceCoverage = "Extended Transit Insurance"
},
requiredCosigners = [
  galleryCurator,
  insuranceProvider,
  securityProvider
]
}

```

Example 2: Commodity Batch Management

```

-- Coffee batch tokenization example
commodityExample :: RealWorldAsset
commodityExample = RealWorldAsset {
  assetId = "coffee_batch_001",
  assetType = Commodity {
    type = "Arabica Coffee",
    grade = "Premium",
    origin = "Colombia",
    harvest = "2024",
    quantity = MetricTons 100
  },
  assetValue = 1_000_000_000_000, -- 1M ADA
  requirementSet = [
    Requirement {
      requirementType = Environmental,
      description = "Storage humidity 60-65%",
      validationMethod = HumiditySensorValidation,
      verificationFrequency = Daily,
      requirementStatus = Active
    }
  ]
}

-- Storage condition change proposal
proposeStorageChange :: ProposalParams

```

```

proposeStorageChange = ProposalParams {
  description = "Update storage conditions",
  effect = StorageConditionChange {
    newHumidity = Percentage 62,
    newTemperature = Celsius 20,
    implementation = "Automated climate control"
  },
  requiredCosigners = [
    warehouseManager,
    qualityInspector
  ]
}

```

3. Phase Transition Scenarios

Lock Phase Implementation

```

data LockPhaseInfo = LockPhaseInfo {
  startTime :: POSIXTime,
  endTime :: POSIXTime,
  requiredStake :: Integer,
  currentStake :: Integer,
  lockedTokens :: Map PubKeyHash Integer
}

startLockPhase :: ProposalId -> Contract w s Text ()
startLockPhase proposalId = do
  proposal <- getProposal proposalId
  currentTime <- getCurrentTime

  let lockInfo = LockPhaseInfo {
    startTime = currentTime,
    endTime = currentTime + proposal.lockDuration,
    requiredStake = calculateRequiredStake proposal,
    currentStake = 0,
    lockedTokens = Map.empty
  }

  validateLockPhaseStart proposal
  updateProposalPhase proposalId (LockPhase lockInfo)

```

```
emitLockPhaseStarted proposalId
```

```
validateLockPhaseStart :: Proposal -> Bool
```

```
validateLockPhaseStart proposal =
```

```
  hasMinimumCreationStake &&
```

```
  notInActivePhase &&
```

```
  allRequirementsValid
```

Voting Phase Implementation

```
data VotingPhaseInfo = VotingPhaseInfo {
```

```
  votes :: Map PubKeyHash Vote,
```

```
  totalVotingPower :: Integer,
```

```
  usedVotingPower :: Integer,
```

```
  voteDistribution :: VoteDistribution
```

```
}
```

```
data Vote = Vote {
```

```
  direction :: VoteDirection,
```

```
  power :: Integer,
```

```
  timestamp :: POSIXTime,
```

```
  metadata :: VoteMetadata
```

```
}
```

```
startVotingPhase :: ProposalId -> Contract w s Text ()
```

```
startVotingPhase proposalId = do
```

```
  proposal <- getProposal proposalId
```

```
-- Verify lock phase completion
```

```
unless (isLockPhaseComplete proposal) $
```

```
  throwError "Lock phase incomplete"
```

```
-- Verify start threshold
```

```
unless (meetsStartThreshold proposal) $
```

```
  throwError "Insufficient stake for voting start"
```

```
let votingInfo = VotingPhaseInfo {
```

```
  votes = Map.empty,
```

```
  totalVotingPower = calculateTotalPower proposal,
```

```
  usedVotingPower = 0,
```

```

        voteDistribution = initializeVoteDistribution
    }

    updateProposalPhase proposalId (VotingPhase votingInfo)
    emitVotingPhaseStarted proposalId

```

4. Threshold Calculations

Practical Examples

```

-- Example: Art piece worth 10M ADA
calculateThresholds :: AssetValue -> AgoraThresholds
calculateThresholds assetValue = AgoraThresholds {
    creation = Percentage 5,    -- 500k ADA to create proposal
    start = Percentage 10,     -- 1M ADA to start voting
    vote = Percentage 15,      -- 1.5M ADA for valid vote
    execution = Percentage 51, -- 5.1M ADA to execute
    cosigning = Percentage 25  -- 2.5M ADA for cosigning
}

-- Example: Calculating voting power
calculateVotingPower :: TokenAmount -> VotingStrategy -> Integer
calculateVotingPower amount strategy = case strategy of
    Linear ->
        amount
    Quadratic ->
        floor $ sqrt $ fromIntegral amount
    WeightedByTime holdingTime ->
        amount * (1 + (holdingTime `div` 30)) -- Bonus for longer holds

```

5. Governance Flows

Complete Proposal Lifecycle

```

data ProposalLifecycle = ProposalLifecycle {
    proposal :: Proposal,
    currentPhase :: AgoraPhase,
    history :: [PhaseTransition],
    votes :: Map PubKeyHash Vote,
    effects :: [Effect],

```

```

status :: ProposalStatus
}

executeProposalLifecycle :: ProposalId -> Contract w s Text ()
executeProposalLifecycle proposalId = do
  -- Initialize proposal
  proposal <- createProposal proposalId

  -- Lock phase
  startLockPhase proposalId
  awaitLockPhaseCompletion proposalId

  -- Voting phase
  startVotingPhase proposalId
  collectVotes proposalId

  -- Execution phase
  validateVotingResults proposalId
  collectCosignatures proposalId
  executeEffects proposalId

```

6. Implementation Considerations

Security Measures

```

data SecurityMeasures = SecurityMeasures {
  accessControl :: AccessControl,
  thresholdValidation :: ThresholdValidation,
  timelock :: TimelockConfig,
  emergencyProcedures :: EmergencyProcedures
}

validateSecurityMeasures :: SecurityMeasures -> ScriptContext -> Bool
validateSecurityMeasures measures ctx =
  validateAccess measures.accessControl ctx &&
  validateThresholds measures.thresholdValidation ctx &&
  validateTimelock measures.timelock ctx

```

Error Handling


```
data GovernanceError =  
  InsufficientStake Text  
| InvalidPhaseTransition Text  
| ThresholdNotMet Text  
| ValidationFailed Text  
| TimelockNotExpired Text  
  
handleGovernanceError :: GovernanceError -> Contract w s Text a  
handleGovernanceError = \case  
  InsufficientStake msg ->  
    logError $ "Stake requirement not met: " <> msg  
  InvalidPhaseTransition msg ->  
    logError $ "Invalid phase transition: " <> msg  
  ThresholdNotMet msg ->  
    logError $ "Threshold not met: " <> msg  
  ValidationFailed msg ->  
    logError $ "Validation failed: " <> msg  
  TimelockNotExpired msg ->  
    logError $ "Timelock not expired: " <> msg
```

This implementation guide demonstrates how the Agora governance protocol can be used effectively with various real-world assets, providing both technical implementation details and practical examples that engineers can follow.

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