Temporal Training Session 6: Timers, Sleep, and External Waits

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Introduction and Recap

Welcome to Day 6 of our Temporal training. Over the past five days, we've built a comprehensive understanding of Temporal's core components:

- **Day 1:** We explored the historical context and fundamental architecture
- **Day 2:** We delved into workflows and the critical concept of determinism
- **Day 3:** We mastered activities, retries, and idempotency
- **Day 4:** We learned about task queues and worker management
- **Day 5:** We explored signals and queries for workflow interaction

Today, we focus on **time-based operations** in Temporal workflows. Time is a fundamental aspect of business processes—approvals need deadlines, payments have processing windows, and notifications require delays. Understanding how to handle time correctly in Temporal is crucial for building robust, production-ready workflows.

Today's Learning Objectives:

- Differentiate between durable timers and standard time.sleep()
- Master Workflow.sleep() for delays and reminders
- Implement strategies for waiting on external conditions
- Combine signals and timers for human-in-the-loop workflows
- Understand advanced timer patterns and best practices

Understanding Durable Timers vs. Standard Sleep

The Problem with Standard Sleep

In traditional programming, when you need to pause execution, you might use:

```
import time
import asyncio

# Synchronous sleep - BLOCKS the entire thread
time.sleep(10)

# Asynchronous sleep - still not durable
await asyncio.sleep(10)
```

Why these don't work in Temporal workflows:

1. **Non-Deterministic:** The actual sleep duration depends on system load, scheduling, and other factors
2. **Non-Durable:** If the worker crashes during sleep, the sleep state is lost
3. **Resource Waste:** The worker thread is blocked, preventing it from processing other tasks
4. **No Persistence:** The sleep state isn't recorded in the workflow history

Temporal's Durable Sleep

Temporal provides `workflow.sleep()` as a durable, deterministic alternative:

```
from datetime import timedelta
from temporalio import workflow

@workflow.defn
class TimerWorkflow:
    @workflow.run
    async def run(self, delay_seconds: int) -> str:
        workflow.logger.info(f"Starting workflow, will sleep for
{delay_seconds} seconds")

        # Durable sleep - persists across worker restarts
        await workflow.sleep(delay_seconds)

        workflow.logger.info("Sleep completed, continuing workflow")
        return "Workflow completed after sleep"
```

How Workflow.sleep() Works:

1. **Command Generation:** When you call `workflow.sleep(duration)`, the Temporal SDK generates a `StartTimer` command
2. **History Recording:** This command is recorded in the workflow's event history as a `TimerStarted` event
3. **Server-Side Timer:** The Temporal server creates a timer that will fire after the specified duration
4. **Workflow Suspension:** The workflow execution is suspended, and the worker can process other tasks
5. **Timer Firing:** When the timer expires, the server generates a `TimerFired` event

6. **Workflow Resumption:** The workflow is scheduled to resume, and execution continues from where it left off

Key Benefits:

- **Durable:** Timer state persists across worker crashes and restarts
- **Deterministic:** The timer duration is exactly what you specify
- **Efficient:** Workers aren't blocked during sleep
- **Auditable:** All timer events are recorded in the workflow history

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Effective Use of Workflow.sleep()

Basic Timer Usage

```
from datetime import timedelta
from temporalio import workflow

@workflow.defn
class ReminderWorkflow:
    @workflow.run
    async def run(self, user_id: str, reminder_delay: int) -> str:
        workflow.logger.info(f"Setting up reminder for user {user_id}")

        # Wait for the specified delay
        await workflow.sleep(reminder_delay)

        # Send the reminder (via activity)
        await workflow.execute_activity(
            send_reminder_activity,
            user_id,
            start_to_close_timeout=timedelta(seconds=30)
        )

        return f"Reminder sent to user {user_id}"
```

Timer with Dynamic Duration

```
@workflow.defn
class AdaptiveDelayWorkflow:
    @workflow.run
    async def run(self, base_delay: int, retry_count: int = 0) -> str:
        # Calculate delay with exponential backoff
        delay = base_delay * (2 ** retry_count)

        workflow.logger.info(f"Waiting {delay} seconds before retry
{retry_count}")
        await workflow.sleep(delay)
```

```
        # Attempt the operation
        try:
            result = await workflow.execute_activity(
                risky_operation_activity,
                start_to_close_timeout=timedelta(seconds=60)
            )
            return result
        except Exception as e:
            if retry_count < 3:
                # Recursive retry with increased delay
                return await self.run(base_delay, retry_count + 1)
            else:
                raise e
```

Multiple Timers in Sequence

```
@workflow.defn
class MultiStageWorkflow:
    @workflow.run
    async def run(self) -> str:
        workflow.logger.info("Starting multi-stage workflow")

        # Stage 1: Initial processing
        await workflow.execute_activity(initial_processing_activity)

        # Wait 5 minutes before stage 2
        await workflow.sleep(300)

        # Stage 2: Secondary processing
        await workflow.execute_activity(secondary_processing_activity)

        # Wait 10 minutes before final stage
        await workflow.sleep(600)

        # Stage 3: Final processing
        result = await workflow.execute_activity(final_processing_activity)

        return result
```

Timer with Cancellation

```
@workflow.defn
class CancellableTimerWorkflow:
    def __init__(self):
        self.timer_cancelled = False

    @workflow.run
    async def run(self, timeout_seconds: int) -> str:
        # Start a timer for the timeout
```

```
        timer_handle = workflow.start_timer(timeout_seconds)

        # Wait for either the timer to fire or a cancellation signal
        await workflow.wait_condition(lambda: self.timer_cancelled)

        if self.timer_cancelled:
            timer_handle.cancel()
            return "Timer was cancelled"
        else:
            return "Timer completed"

    @workflow.signal
    async def cancel_timer(self):
        self.timer_cancelled = True
```

Strategies for External Waits

Waiting for External Conditions

Sometimes you need to wait for external conditions that aren't time-based. Temporal provides several patterns for this:

Pattern 1: Polling with Timers

```
@workflow.defn
class PollingWorkflow:
    @workflow.run
    async def run(self, resource_id: str, max_wait_seconds: int) -> str:
        start_time = workflow.now()

        while True:
            # Check if the external condition is met
            status = await workflow.execute_activity(
                check_resource_status_activity,
                resource_id,
                start_to_close_timeout=timedelta(seconds=30)
            )

            if status == "ready":
                return f"Resource {resource_id} is ready"

            # Check if we've exceeded the maximum wait time
            elapsed = (workflow.now() - start_time).total_seconds()
            if elapsed > max_wait_seconds:
                raise Exception(f"Timeout waiting for resource
{resource_id}")

            # Wait before the next poll
            await workflow.sleep(60)  # Poll every minute
```

Pattern 2: Signal-Based Waiting

```python
@workflow.defn
class SignalWaitWorkflow:
    def __init__(self):
        self.external_event_received = False
        self.event_data = None

    @workflow.run
    async def run(self, timeout_seconds: int) -> str:
        # Wait for external signal or timeout
        await workflow.wait_condition(
            lambda: self.external_event_received,
            timeout=timeout_seconds
        )

        if self.external_event_received:
            return f"Received external event: {self.event_data}"
        else:
            return "Timeout waiting for external event"

    @workflow.signal
    async def external_event(self, data: str):
        self.external_event_received = True
        self.event_data = data
```

Pattern 3: Hybrid Approach

```python
@workflow.defn
class HybridWaitWorkflow:
    def __init__(self):
        self.condition_met = False
        self.last_check_time = None

    @workflow.run
    async def run(self, max_wait_seconds: int) -> str:
        start_time = workflow.now()

        while not self.condition_met:
            # Check if timeout exceeded
            elapsed = (workflow.now() - start_time).total_seconds()
            if elapsed > max_wait_seconds:
                raise Exception("Timeout waiting for condition")

            # Wait for either a signal or a timer
            await workflow.wait_condition(
                lambda: self.condition_met,
                timeout=300  # Check every 5 minutes
            )
```

```
            # If no signal received, check the condition manually
            if not self.condition_met:
                self.condition_met = await workflow.execute_activity(
                    check_external_condition_activity
                )

        return "Condition met successfully"

    @workflow.signal
    async def condition_signal(self):
        self.condition_met = True
```

Combining Signals and Timers

Human-in-the-Loop Workflows

One of the most powerful patterns in Temporal is combining signals and timers for human-in-the-loop workflows:

```
@workflow.defn
class ApprovalWorkflow:
    def __init__(self):
        self.approval_received = False
        self.approval_decision = None
        self.escalation_sent = False

    @workflow.run
    async def run(self, request_id: str, approver_id: str) -> str:
        workflow.logger.info(f"Starting approval workflow for request
{request_id}")

        # Send initial approval request
        await workflow.execute_activity(
            send_approval_request_activity,
            request_id,
            approver_id,
            start_to_close_timeout=timedelta(seconds=30)
        )

        # Wait for approval or timeout (24 hours)
        approval_timeout = 24 * 60 * 60  # 24 hours in seconds

        try:
            await workflow.wait_condition(
                lambda: self.approval_received,
                timeout=approval_timeout
            )

            if self.approval_decision == "approved":
```

```
                return await self.process_approval(request_id)
            else:
                return await self.process_rejection(request_id)

        except TimeoutError:
            # Handle timeout - escalate to manager
            return await self.handle_timeout(request_id, approver_id)

    @workflow.signal
    async def approve(self, decision: str, comments: str = ""):
        self.approval_received = True
        self.approval_decision = decision

        workflow.logger.info(f"Approval decision received: {decision}")

    async def handle_timeout(self, request_id: str, approver_id: str) ->
str:
        if not self.escalation_sent:
            # Send escalation notification
            await workflow.execute_activity(
                escalate_approval_activity,
                request_id,
                approver_id,
                start_to_close_timeout=timedelta(seconds=30)
            )
            self.escalation_sent = True

            # Wait additional time for escalation response
            await workflow.sleep(4 * 60 * 60)  # 4 more hours

            # Auto-approve if still no response
            return await self.process_approval(request_id)

        return "Request auto-approved due to timeout"

    async def process_approval(self, request_id: str) -> str:
        await workflow.execute_activity(
            process_approved_request_activity,
            request_id,
            start_to_close_timeout=timedelta(seconds=60)
        )
        return f"Request {request_id} approved and processed"

    async def process_rejection(self, request_id: str) -> str:
        await workflow.execute_activity(
            process_rejected_request_activity,
            request_id,
            start_to_close_timeout=timedelta(seconds=30)
        )
        return f"Request {request_id} rejected"
```

Advanced Signal-Timer Patterns

Pattern 1: Graceful Degradation

```
@workflow.defn
class GracefulDegradationWorkflow:
    def __init__(self):
        self.primary_response = None
        self.fallback_triggered = False

    @workflow.run
    async def run(self, request_id: str) -> str:
        # Try primary service with short timeout
        try:
            self.primary_response = await workflow.execute_activity(
                call_primary_service_activity,
                request_id,
                start_to_close_timeout=timedelta(seconds=10)
            )
            return self.primary_response
        except Exception:
            workflow.logger.warning("Primary service failed, using
fallback")

        # Wait for manual override or use fallback
        try:
            await workflow.wait_condition(
                lambda: self.primary_response is not None,
                timeout=300  # 5 minutes
            )
            return self.primary_response
        except TimeoutError:
            # Use fallback service
            return await workflow.execute_activity(
                call_fallback_service_activity,
                request_id,
                start_to_close_timeout=timedelta(seconds=30)
            )

    @workflow.signal
    async def manual_override(self, response: str):
        self.primary_response = response
```

Pattern 2: Batch Processing with Timeout

```
@workflow.defn
class BatchProcessingWorkflow:
    def __init__(self):
        self.batch_items = []
        self.processing_complete = False
        self.batch_size = 10
        self.max_wait_time = 3600  # 1 hour
```

```
    @workflow.run
    async def run(self, initial_items: list) -> str:
        self.batch_items.extend(initial_items)
        start_time = workflow.now()

        while not self.processing_complete:
            # Check if we have enough items or timeout reached
            elapsed = (workflow.now() - start_time).total_seconds()

            if len(self.batch_items) >= self.batch_size or elapsed >=
self.max_wait_time:
                # Process the batch
                result = await workflow.execute_activity(
                    process_batch_activity,
                    self.batch_items,
                    start_to_close_timeout=timedelta(seconds=300)
                )
                self.processing_complete = True
                return result
            else:
                # Wait for more items or timeout
                remaining_time = self.max_wait_time - elapsed
                await workflow.wait_condition(
                    lambda: len(self.batch_items) >= self.batch_size,
                    timeout=min(remaining_time, 300)  # Check every 5
minutes
                )

        return "Batch processing completed"

    @workflow.signal
    async def add_item(self, item: str):
        self.batch_items.append(item)
        workflow.logger.info(f"Added item to batch. Current size:
{len(self.batch_items)}")
```

Advanced Timer Patterns

Timer with Retry Logic

```
@workflow.defn
class RetryTimerWorkflow:
    @workflow.run
    async def run(self, max_retries: int = 3) -> str:
        retry_count = 0

        while retry_count <= max_retries:
            try:
                # Attempt the operation
```

```
                result = await workflow.execute_activity(
                    risky_operation_activity,
                    start_to_close_timeout=timedelta(seconds=60)
                )
                return result

            except Exception as e:
                retry_count += 1
                if retry_count > max_retries:
                    raise e

                # Exponential backoff with jitter
                base_delay = 60 * (2 ** (retry_count - 1))  # 60s, 120s,
240s
                jitter = random.randint(0, 30)  # Add 0-30s jitter
                delay = base_delay + jitter

                workflow.logger.info(f"Retry {retry_count} failed, waiting
{delay}s")
                await workflow.sleep(delay)

        raise Exception("Max retries exceeded")
```

Timer with Conditional Logic

```
@workflow.defn
class ConditionalTimerWorkflow:
    def __init__(self):
        self.condition_met = False
        self.timer_active = True

    @workflow.run
    async def run(self, check_interval: int = 300) -> str:
        while self.timer_active:
            # Check the condition
            self.condition_met = await workflow.execute_activity(
                check_condition_activity,
                start_to_close_timeout=timedelta(seconds=30)
            )

            if self.condition_met:
                self.timer_active = False
                return "Condition met, workflow completed"

            # Wait before next check
            await workflow.sleep(check_interval)

        return "Workflow completed"

    @workflow.signal
```

```
    async def stop_timer(self):
        self.timer_active = False
```

Timer with Dynamic Intervals

```
@workflow.defn
class AdaptiveTimerWorkflow:
    def __init__(self):
        self.current_interval = 60  # Start with 1 minute
        self.max_interval = 3600    # Max 1 hour
        self.min_interval = 10      # Min 10 seconds

    @workflow.run
    async def run(self) -> str:
        while True:
            # Perform the periodic task
            result = await workflow.execute_activity(
                periodic_task_activity,
                start_to_close_timeout=timedelta(seconds=30)
            )

            # Adjust interval based on result
            if result.get("high_priority"):
                self.current_interval = max(self.min_interval,
self.current_interval // 2)
            elif result.get("low_priority"):
                self.current_interval = min(self.max_interval,
self.current_interval * 2)

            workflow.logger.info(f"Next check in {self.current_interval}
seconds")
            await workflow.sleep(self.current_interval)
```

Real-World Examples

Example 1: Payment Processing with Timeout

```
@workflow.defn
class PaymentProcessingWorkflow:
    def __init__(self):
        self.payment_confirmed = False
        self.payment_failed = False

    @workflow.run
    async def run(self, payment_id: str, amount: float) -> str:
        workflow.logger.info(f"Processing payment {payment_id} for
${amount}")
```

```
        # Initiate payment
        await workflow.execute_activity(
            initiate_payment_activity,
            payment_id,
            amount,
            start_to_close_timeout=timedelta(seconds=30)
        )

        # Wait for confirmation or timeout (30 minutes)
        try:
            await workflow.wait_condition(
                lambda: self.payment_confirmed or self.payment_failed,
                timeout=1800  # 30 minutes
            )

            if self.payment_confirmed:
                return await self.finalize_payment(payment_id)
            else:
                return await self.handle_payment_failure(payment_id)

        except TimeoutError:
            return await self.handle_timeout(payment_id)

    @workflow.signal
    async def payment_confirmation(self, status: str):
        if status == "confirmed":
            self.payment_confirmed = True
        else:
            self.payment_failed = True

    async def finalize_payment(self, payment_id: str) -> str:
        await workflow.execute_activity(
            finalize_payment_activity,
            payment_id,
            start_to_close_timeout=timedelta(seconds=60)
        )
        return f"Payment {payment_id} finalized successfully"

    async def handle_payment_failure(self, payment_id: str) -> str:
        await workflow.execute_activity(
            handle_payment_failure_activity,
            payment_id,
            start_to_close_timeout=timedelta(seconds=30)
        )
        return f"Payment {payment_id} failed"

    async def handle_timeout(self, payment_id: str) -> str:
        await workflow.execute_activity(
            handle_payment_timeout_activity,
            payment_id,
            start_to_close_timeout=timedelta(seconds=30)
        )
        return f"Payment {payment_id} timed out"
```

Example 2: Order Fulfillment with SLA Monitoring

```python
@workflow.defn
class OrderFulfillmentWorkflow:
    def __init__(self):
        self.order_status = "processing"
        self.sla_breached = False

    @workflow.run
    async def run(self, order_id: str) -> str:
        workflow.logger.info(f"Starting fulfillment for order {order_id}")

        # Start SLA monitoring timer (24 hours)
        sla_timer = workflow.start_timer(24 * 60 * 60)

        try:
            # Process order
            await workflow.execute_activity(
                process_order_activity,
                order_id,
                start_to_close_timeout=timedelta(seconds=300)
            )

            # Wait for inventory confirmation
            await workflow.wait_condition(
                lambda: self.order_status == "inventory_confirmed",
                timeout=3600  # 1 hour
            )

            # Ship order
            await workflow.execute_activity(
                ship_order_activity,
                order_id,
                start_to_close_timeout=timedelta(seconds=180)
            )

            # Cancel SLA timer since we completed on time
            sla_timer.cancel()

            return f"Order {order_id} fulfilled successfully"

        except Exception as e:
            # Check if SLA was breached
            if not sla_timer.is_cancelled():
                self.sla_breached = True
                await workflow.execute_activity(
                    handle_sla_breach_activity,
                    order_id,
                    start_to_close_timeout=timedelta(seconds=30)
                )
```

```
            raise e

    @workflow.signal
    async def inventory_confirmed(self):
        self.order_status = "inventory_confirmed"

    @workflow.query
    def get_status(self) -> dict:
        return {
            "order_status": self.order_status,
            "sla_breached": self.sla_breached
        }
```

Best Practices and Anti-Patterns

Best Practices

1. **Use Appropriate Timeouts:**

```
# Good: Reasonable timeout for external API calls
await workflow.execute_activity(
    call_external_api_activity,
    start_to_close_timeout=timedelta(seconds=30)
)

# Good: Longer timeout for batch processing
await workflow.execute_activity(
    process_large_dataset_activity,
    start_to_close_timeout=timedelta(hours=2)
)
```

2. **Combine Timers with Signals:**

```
# Good: Wait for signal with timeout fallback
try:
    await workflow.wait_condition(
        lambda: self.condition_met,
        timeout=3600  # 1 hour timeout
    )
except TimeoutError:
    # Handle timeout gracefully
    await self.handle_timeout()
```

3. **Use Exponential Backoff:**

```
# Good: Exponential backoff for retries
base_delay = 60 * (2 ** retry_count)
await workflow.sleep(base_delay)
```

4. **Cancel Timers When No Longer Needed:**

```
# Good: Cancel timer when condition is met
timer_handle = workflow.start_timer(3600)
try:
    await workflow.wait_condition(lambda: self.condition_met)
    timer_handle.cancel()  # Cancel if condition met early
except TimeoutError:
    # Timer fired, handle timeout
    pass
```

Anti-Patterns

1. **Avoid Infinite Loops:**

```
# Bad: Infinite loop without timeout
while True:
    await workflow.sleep(60)
    # This will run forever

# Good: Loop with exit condition
while not self.completed:
    await workflow.sleep(60)
    self.completed = await self.check_condition()
```

2. **Don't Use Standard Sleep:**

```
# Bad: Using standard sleep
import time
time.sleep(10)  # This will break determinism

# Good: Using workflow.sleep
await workflow.sleep(10)
```

3. **Avoid Very Short Timers:**

```
# Bad: Very short timer (less than 1 second)
await workflow.sleep(0.1)  # This can cause performance issues
```

```
# Good: Reasonable timer duration
await workflow.sleep(1)  # Minimum 1 second
```

4. **Don't Ignore Timer Cancellation:**

```
# Bad: Not checking if timer was cancelled
timer_handle = workflow.start_timer(3600)
await workflow.wait_condition(lambda: self.condition_met)
# Timer might still be running

# Good: Cancel timer when no longer needed
timer_handle = workflow.start_timer(3600)
await workflow.wait_condition(lambda: self.condition_met)
timer_handle.cancel()  # Cancel the timer
```

Performance Considerations

Timer Overhead

- **Server-Side Timers:** Timers are managed by the Temporal server, not workers
- **Memory Usage:** Each timer consumes a small amount of server memory
- **Scalability:** Temporal can handle millions of concurrent timers efficiently

Best Practices for Performance

1. **Batch Timer Operations:**

```
# Good: Batch multiple operations
await workflow.sleep(300)  # 5 minutes
results = await asyncio.gather(*[
    workflow.execute_activity(activity_1),
    workflow.execute_activity(activity_2),
    workflow.execute_activity(activity_3)
])
```

2. **Use Appropriate Timer Granularity:**

```
# Good: Use reasonable intervals
await workflow.sleep(60)  # 1 minute intervals

# Avoid: Too frequent checks
await workflow.sleep(1)  # 1 second intervals
```

3. **Limit Concurrent Timers:**

```
# Good: Limit number of active timers
max_concurrent_timers = 10
active_timers = []

for i in range(max_concurrent_timers):
    timer_handle = workflow.start_timer(3600)
    active_timers.append(timer_handle)
```

Troubleshooting Timer Issues

Common Timer Problems

1. **Timer Not Firing:**
   - Check if the workflow is still running
   - Verify the timer duration is reasonable
   - Check Temporal server logs for errors
2. **Timer Firing Too Early:**
   - Ensure you're using `workflow.sleep()` not standard sleep
   - Check for workflow replay issues
   - Verify timer duration calculation
3. **Timer Cancellation Issues:**
   - Ensure timer handle is accessible
   - Check if timer was already cancelled
   - Verify cancellation timing

Debugging Techniques

```
@workflow.defn
class DebugTimerWorkflow:
    @workflow.run
    async def run(self, delay_seconds: int) -> str:
        start_time = workflow.now()
        workflow.logger.info(f"Starting timer for {delay_seconds} seconds")

        await workflow.sleep(delay_seconds)

        end_time = workflow.now()
        actual_delay = (end_time - start_time).total_seconds()

        workflow.logger.info(f"Timer completed. Expected: {delay_seconds}s,
Actual: {actual_delay}s")

        return f"Timer completed after {actual_delay} seconds"
```

Monitoring Timer Performance

```
@workflow.defn
class MonitoredTimerWorkflow:
    @workflow.run
    async def run(self) -> dict:
        timer_metrics = {
            "start_time": workflow.now(),
            "timer_durations": [],
            "total_timers": 0
        }

        for i in range(5):
            timer_start = workflow.now()
            await workflow.sleep(60)  # 1 minute
            timer_end = workflow.now()

            duration = (timer_end - timer_start).total_seconds()
            timer_metrics["timer_durations"].append(duration)
            timer_metrics["total_timers"] += 1

        timer_metrics["end_time"] = workflow.now()
        timer_metrics["average_duration"] =
sum(timer_metrics["timer_durations"]) /
len(timer_metrics["timer_durations"])

        return timer_metrics
```

Summary

Today we've explored the critical aspects of time-based operations in Temporal workflows:

Key Takeaways:

1. **Durable Timers:** Use `workflow.sleep()` instead of standard sleep for durable, deterministic timing
2. **External Waits:** Combine timers with signals and conditions for flexible waiting patterns
3. **Human-in-the-Loop:** Implement approval workflows with timeouts and escalation
4. **Performance:** Use appropriate timer intervals and batch operations when possible
5. **Best Practices:** Follow patterns for retry logic, cancellation, and error handling

Advanced Patterns Covered:

- Signal-timer combinations for human-in-the-loop workflows
- Polling with exponential backoff
- SLA monitoring with timeout handling
- Batch processing with dynamic intervals
- Graceful degradation with fallback mechanisms

Real-World Applications:

- Payment processing with confirmation timeouts
- Order fulfillment with SLA monitoring
- Approval workflows with escalation
- Batch processing with dynamic batching

Tomorrow, on Day 7, we'll dive into comprehensive error handling and retry strategies, building on the timer concepts we learned today to create even more robust workflows.

Next Steps:

- Practice implementing timer-based workflows
- Experiment with signal-timer combinations
- Test timeout and cancellation scenarios
- Monitor timer performance in your applications

Remember: Time is a fundamental aspect of business processes, and mastering temporal timers is essential for building production-ready workflows that can handle real-world scenarios reliably and efficiently.