TL; DR

TODO:

0.1 Structure

- `EffectableComponent`**s** are `ActorComponent`s that allow for delegation (effects). They have predefined places called "`Outlet`s" that allow for code modification. Think of `Outlet`s like electrical outlets waiting to be plugged into.
  - Let's use `StatsComponent` as an example. Say we want a Pokémon-style "Adamant" nature (+10% PhA/−10% SpA). One such place for modification is in the function `RecalculateStats`.

```
void UCombatStatsComponent::RecalculateStats(const bool bResetCurrent, const bool bResetHP)
{
    for(const EStatEnum Stat : StatsArray)
    {

        // Cache for delegates
        FCombatStat& TargetStat = GetStatMutable(Stat);
        const float OriginalCurrent = TargetStat.GetCurrentValue();
        const float OriginalPermanent = TargetStat.GetPermanentValue();

        // Resetting this stat?
        bool bReset = bResetCurrent;
        if (Stat == EStatEnum::Health)
        {
            bReset &= bResetHP;
        }

        // Call + execute + call
        RecalculateStatsOutlet.ExecuteBefore(Stat, bReset, OriginalCurrent, OriginalPermanent);
        TargetStat.Update(LevelComponent->GetLevel(), bReset);
        RecalculateStatsOutlet.ExecuteAfter(Stat, bReset, OriginalCurrent, OriginalPermanent);
    }
}
```

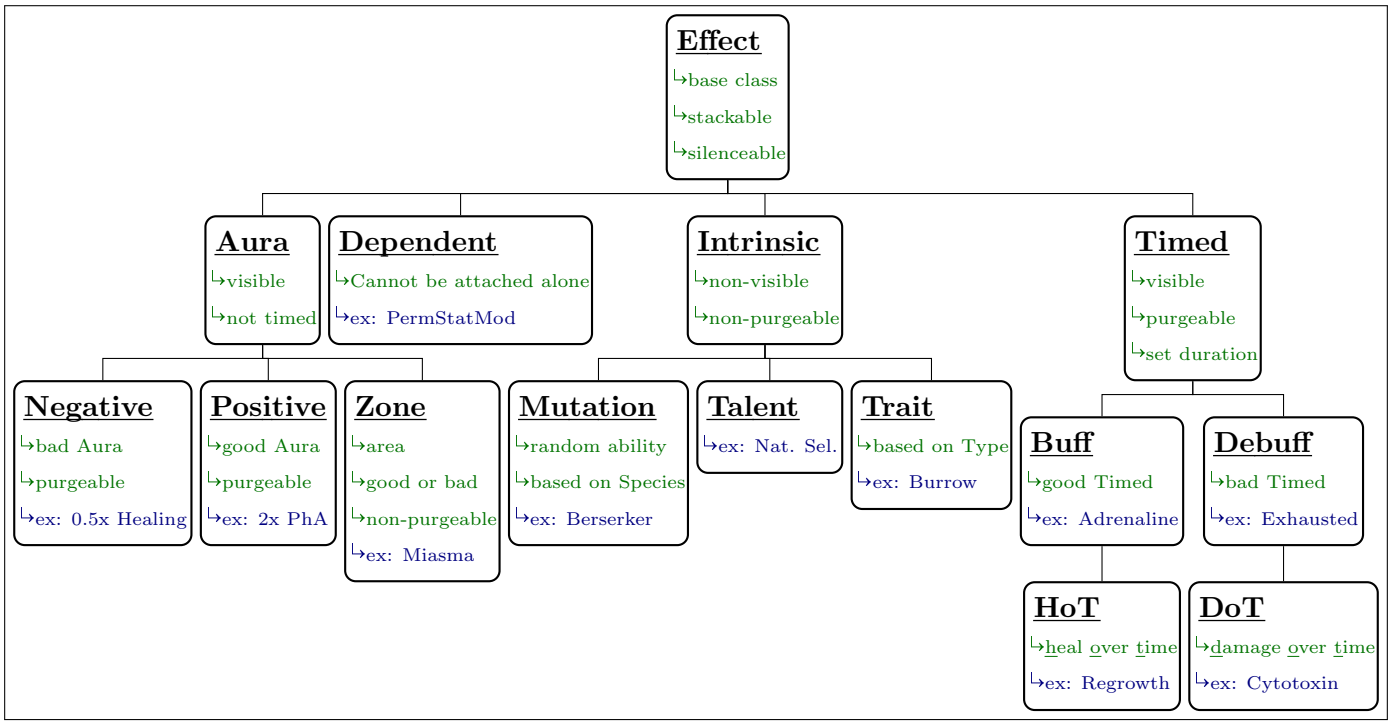
- `Outlet` **arrays** are variables inside of `EffectableComponent`s. They hold `Outlet`s whose delegates execute when needed.
  - `TODO: Update this!` Let's use `StatsComponent`'s `AfterRecalculateStatsArray` in our example. In this case, after stats are recalculated (say, on level-up), the base PhA would increase by 10% and the base SpA would decrease by 10% (additively):

```cpp
// Define "adamant" delegate (+10% PhA/-10% SpA)
UStatsComponent::FRecalculateStatsDelegate AdamantRecalculateDelegate;
AdamantRecalculateDelegate.BindLambda( InFunctor: [StatsComponent](FStat* Stat, bool bResetCurrent) ->void
{

    // +10% PhA
    if ( Stat->Name() == StatsComponent->PhysicalAttack.Name())
    {
        Stat->ModifyValue( Modifier: 10, EStatValueType::Permanent, EModificationMode::AddPercentage);
        if (bResetCurrent)
            Stat->ModifyValue( Modifier: 10, EStatValueType::Current, EModificationMode::AddPercentage);
    }

    // -10% SpA
    if ( Stat->Name() == StatsComponent->SpecialAttack.Name())
    {
        Stat->ModifyValue( Modifier: -10, EStatValueType::Permanent, EModificationMode::AddPercentage);
        if (bResetCurrent)
            Stat->ModifyValue( Modifier: -10, EStatValueType::Current, EModificationMode::AddPercentage);
    }

});
StatsComponent->AfterRecalculateStatsArray.Add(AdamantRecalculateDelegate);
```

- `EffectComponent`**s** are `ActorComponent`s that plug into `Outlet`s. These come in many forms, but an easy example is a `Buff`. `TODO: Describe how this happens with pictures!`

0.2 `EffectComponent` Inheritance

The base classes inherit as:



Some notes:

- Only the base names have been used. That is, the actual names may be `UTimedEffectComponent` instead of simply "Timed".
- "Purgeable" means it is possible to reduce the stacks of the `UEffectComponent` down to zero (detachment of `UEffectComponent`).
- All `UEffectComponent`s are "silenceable", meaning their effects can be nullified (but not detached or reduced in stacks).
- "Persistent" (meaning that the `UEffectComponent` is not removed upon switching out) should be set on an effect-by-effect basis and not set by the inherited class. For example, some `UNegativeAuraComponent`s (such as Pokémon's Paralysis) may persist upon switching out and others (such as Pokémon's Confusion) may not.

0.3 List of `EffectableComponents` and `Outlets`

The following tables show all implemented `EffectableComponent`s and their delegate arrays. Note the "base name" indicates existence of "Before" and "After" versions of:

1. the delegate signatures, `FBeforeBaseNameSignature`;
2. the delegate wrappers, `FBeforeBaseNameDelegate`, which are necessary since `TArray`s cannot contain delegates;
3. the private arrays of delegate wrappers, `TArray<FBeforeBaseNameOutlet> BeforeDelegates`;
4. a function to execute the arrays, `ExecuteBeforeBaseName`; and
5. `AddBeforeBaseName`, a function to add an `Outlet` to the private array `BeforeDelegates` (which also puts it in the right order based on priority).

Note that the philosophy applies to what is *probable* rather than what is *possible*. Hence the list meant to be practical rather than exhaustive.

Table 1: `Outlet`s for `UAffinitiesComponent`

GetUnspentPoints	
▸ Before	`const uint8 OriginalPoints,` `uint8& ReturnedPoints`
▸ After	`const uint8 OriginalPoints,` `const uint8 ReturnedPoints`

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Table 1: Outlets for UAffinitiesComponent (Continued)

SetUnspentPoints	
▸ Before	const uint8 OriginalPoints, const uint8 InputPoints, uint8& SetPoints
▸ After	const uint8 OriginalPoints, const uint8 InputPoints, const uint8 SetPoints

• • •

Table 2: Outlets for UEffectComponent

GetStacks	
▸ Before	const uint16 OGStacks, int32& ReturnedStacks
▸ After	const uint16 OGStacks, const int32 ReturnedStacks

OnAddEffect	
▸ Before	const EffectComponent* EffectToAdd
▸ After	const EffectComponent* AddedEffect

OnRemoveEffect	
▸ Before	const EffectComponent* EffectToRemove
▸ After	const EffectComponent* RemovedEffect

• • •

Table 3: Outlets for ULevelComponent

GetBaseExpYield	
▸ Before	const float OriginalYield, float& ReturnedYield
▸ After	const float OriginalYield, const float ReturnedYield

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Table 3: Outlets for ULevelComponent (Continued)

GetCXP	
▸ Before	const uint32 OriginalCXP, int32& ReturnedCXP
Note:	ReturnedCXP is int32& instead of uint32& for Blueprint compatability.
▸ After	const uint32 OriginalCXP const int32 ReturnedCXP
Note:	ReturnedCXP is const int32 instead of const uint32 for Blueprint compatability.

GetExpYield	
▸ Before	const float OriginalYield, float& ReturnedYield, const uint16 DefeatedLevel, const uint16 VictoriousLevel
Note:	"Defeated" and "Victorious" levels are provided for flexibility (e.g., in case you want to yield exp differently based on level difference, although technically you could always back-calculate the level difference based on the equation and OriginalYield).
▸ After	const float OriginalYied, const float ReturnedYield, const uint16 DefeatedLevel, const uint16 VictoriousLevel
Note:	"Defeated" and "Victorious" levels are provided for symmetry with respect to the Before delegate (since ReturnedValue is already calculated, I can't think of why you would need them, but you never know!).

GetMaxLevel	
▸ Before	const uint16 DefaultMax, int32& AttemptedMax
Note:	DefaultMax is defined in the code. It should normally be 100, but may change for certain subclasses (e.g., a UBossLevelComponent may have a max of 200 instead). AttemptedMax is int32& instead of uint16& for Blueprint compatability.
▸ After	const uint16 DefaultMax const int32 ReturnedMax

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Table 3: Outlets for ULevelComponent (Continued)

GetMinLevel	
▸ Before	const uint16 DefaultMin, int32& AttemptedMin
Note:	DefaultMin is defined in the code. It should normally be 1, but may change for certain subclasses (e.g., a UEggLevelComponent may have a min of 0 instead for whatever reason). AttemptedMin is int32& instead of uint16& for Blueprint compatability.
▸ After	const uint16 DefaultMin const int32 ReturnedMin
Note:	ReturnedCXP is const int32 instead of const uint32 for Blueprint compatability.

GetBaseExpYield	
▸ Before	const float OriginalYield, float& ReturnedYield
▸ After	const float OriginalYield, const float ReturnedYield

SetBaseExpYield	
▸ Before	const float OldYield, const float InputYield, float& AttemptedYield
▸ After	const float OldYield const float InputYield, const float NewYield
Note:	▻ OldYield is the yield prior to calling SetBaseExpYield, ▻ InputYield is the original, unmodified input to SetBaseExpYield, ▻ AttemptedYield is the modified value that will be used to set the base exp yield.

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Table 3: Outlets for ULevelComponent (Continued)

SetCXP	
▸ Before	const uint32 OldCXP, const int32 InputCXP, int32& AttemptedCXP
Note:	AttemptedCXP is int32& instead of uint32& for Blueprint compatability.
▸ After	const uint32 OldCXP const int32 InputCXP, const uint32 NewCXP
Note:	UStatsComponent subscribes to this in order to change stats on level change. ▻ OldCXP is the cumulatie experience points prior to calling SetCXP, ▻ InputCXP is the original, unmodified input to SetCXP, ▻ AttemptedCXP is the modified value that will be used to set the cumulative experience points.

Table 4: Outlets for UStatsComponent

ModifyStat	
▸ Before	const EStatEnum TargetStat, const EStatValueType ValueType, const EModificationMode Mode, const float OriginalValue, float& AttemptedValue
▸ After	const EStatEnum TargetStat, const EStatValueType ValueType, const EModificationMode Mode, const float OriginalValue, const float NewValue
Note:	All "ModifyStat" functions from UStatsComponent (such as ModifyStatsUniformly or RandomizeStats) go through ModifyStatInternal, which calls this Outlet.

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Table 4: Outlets for UStatsComponent (Continued)

RandomizeStats	
▸ Before	const EStatEnum TargetStat, const FStatRandParams OriginalParams, FStatRandParams&ParamsToBeUsed
▸ After	const EStatEnum TargetStat, const FStatRandParams OriginalParams, const FStatRandParams UsedParams
Note:	The EStatEnum is not the acutal FStat. To get the FStat (such as FHealth), use UStatsComponent::GetStat(EStatEnum)

RecalculateStats	
▸ Before	const EStatEnum TargetStat, const bool bResetCurrent, const float OriginalCurrent, const float OriginalPermanent
▸ After	const EStatEnum TargetStat, const bool bResetCurrent, const float OriginalCurrent, const float OriginalPermanent

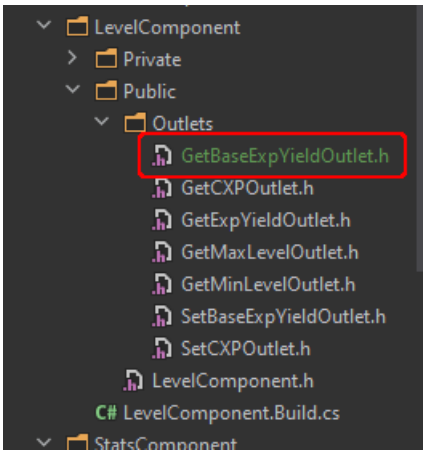
0.4 Making Your Own Outlet

As an example, let's use GetBaseExpYield. (You can imagine that this is an important Outlet for tweaking levelling curves.) Here's what to do:

1. **Plan ahead.** I would sincerely recommend you writing down what parameters your Outlet Before and After delegates take on paper. We go to a few files and it's easy to be inconsistent.

2. **Go to the right directory.** We want to place the Outlet inside of ULevelComponent, so we'll start with that directory. If yours doesn't contain an "Outlets" directory, create one and place your Outlet(s) there.

3. **Copy + paste file.** The easiest way is to copy + paste pre-existing Outlets. In this example, we'll copy + paste SetCXPOutlet.h and name the new file GetBaseExpYield.h.



Note: this includes both `BeforeGetBaseExpYield` *and* `AfterGetBaseExpYield` *functionality. You don't have to make two different files!*

4. **Replace old name.** Open the new file and you'll still see the base name "SetCXP" everywhere. The easiest way is to do a find+replace "SetCXP" → "GetBaseExpYield". This replaces everything from the `.generated` include to the delegate signatures. If you're curious, you can look more in-depth and replace instances one-by-one.

5. **Declare delegate signatures.** In this case, we want the `Before` delegate signature to take two arguments: the original, unmodified yield and the one that will be returned from the `GetBaseExpYield` function.

```
DECLARE_DYNAMIC_DELEGATE_TwoParams(FBeforeGetBaseExpYieldSignature,
    const float, OriginalYield, float&, Yield);
```

You should also set the `After` signature in the same manner. *Note: yours might use more than two parameters or different parameter types. Modify accordingly.*

6. **Module API.** Make sure your module API is correct. If not, you'll get mysterious errors about your dll.

```
/**
 * Since delegates can't fit in TArrays, we need to wrap th
 */
USTRUCT(Blueprintable)
struct LEVELCOMPONENT_API FBeforeGetBaseExpYieldDelegate :
{
    GENERATED_BODY()

public:
```

7. **Declare `Outlet` functions.** In order to be able to call `ExecuteBefore` on your `Outlet`, you need to tell it a few things. The figure below displays a few things in red you should look at:

```
DECLARE_OUTLET_FUNCTIONS_TwoParams(Before, FBeforeGetBaseExpYieldDelegate,
    BeforeDelegates, Delegate, const float, float&);
```

- Whether it's a `Before` or `After` type `Outlet`. This affects execution based on priority:

Priorities

The lower the priority, the farther away it is from execution. If two priorities are tied, the older effect is executed first. Order is set externally by `UEffectsComponent` `TODO: fact check this`. Order:

  - Intrinsic `Before` delegates (no `UEffect` affiliated)
  - `Before` delegates:
    * Priority 1
    * Priority 2.a (older)
    * Priority 2.b (newer)
    * ...
  - [Function executes]
  - `After` delegates:
    * ...
    * Priority 2.b (newer)
    * Priority 2.a (older)
    * Priority 1
  - Intrinsic `After` delegates (have the final say)

As an example, consider two delegates: one that says you can't take damage no matter what (call the `UBuff` "Invincible") and another that says damage against you can't be avoided no matter what (call the `UDebuff` "Weakened"). What happens when the target takes damage? Well, it depends on priority:

  - They're probably subscribed to the `Before` delegate in `UStatsComponent` called `ModifyStatOutlet` with the target `FStat` being `Health`.
  - Note that they're both `Before` delegates.
  - Let's say Invincible has Priority 100 and Weakened has Priority 150. The result is the target takes damage because:
    1) Invincible first sets the damage to zero.
    2) Weakened then sets the damage to no less than its original value.
  - If Weakened has lower Priority, the result is flipped and the target takes no damage.

- The parameters you defined in the delegate's signature. I know, I know—anytime you repeat code, you're probably doing something wrong. The biggest issue here is the UHT. The main (but not only) issue is that you can't have `UPROPERTY`s inside macros or the property won't register. If you have a better way of automating this, *tell me!*

- Don't forget the `After` variant's delegates, which should probably be `const`.

8. **Check number of parameters.** I make a point of this because I find it's my most common error. Make sure your declared signature *and* declared `Outlet` function macros have the correct number of params (two in our case). Explicitly, you might need to use `DECLARE_DYNAMIC_DELEGATE_FourParams(...)`.

9. **Declare `UPROPERTY`.** Inside the `UEffectableComponent` (in this example, `ULevelComponent`), declare the `Outlet` as a variable. Note that it's custom to have this `UPROPERTY` as public and in the "Outlets" category. It's also a good idea to comment the `UPROPERTY` with the parameters.

```
UFUNCTION(BlueprintCallable, BlueprintPure, Category="Level")
float GetBaseExpYield();  0 blueprint usages

/**
 * Before Parameters:
 *  - [const float] original yield prior to modification
 *  - [float&] yield that is being set and then returned
 *
 *  After Parameters:
 *  - [const float] original yield prior to modification
 *  - [const float] yield that is being returned
 */
UPROPERTY(VisibleAnywhere, Category="Level Outlets")
FGetBaseExpYieldOutlet GetBaseExpYieldOutlet;
```

Note: I use Rider, so it imports `#includes` automatically. Make sure yours does, too.

10. **Implement.** Now it's time to place your `Outlet` in the appropriate place(s). For our example, it's pretty simple: place it inside of `GetBaseExpYield` in `ULevelComponent`'s `.cpp` file.

```
float ULevelComponent::GetBaseExpYield()
{
    // Get original for delegates
    const float OriginalBaseExpYield = BaseExpYield;

    // Set up the modifiable return value
    float ReturnedBaseExpYield = BaseExpYield;

    // Call before/after delegates
    GetBaseExpYieldOutlet.ExecuteBefore(OriginalBaseExpYield, &ReturnedBaseExpYield);
    GetBaseExpYieldOutlet.ExecuteAfter(OriginalBaseExpYield, ReturnedBaseExpYield);

    // Return for use in other functions
    return ReturnedBaseExpYield;
}
```

Note that you might have to do things like cache original values.

11. **A note on complementary delegates.** If you create a `Before Outlet`, you should also create an `After Outlet`. The biggest difference might be the delegate signature (e.g., reference "`&`" to `const`).

    An example where this would be necessary is an animation delegate. You only want to fire a "bonus exp" animation *after* the amount of exp has been determined, checked, and is now constant.

    In some cases, it may not be necessary to have both `Before` and `After` delegates in a function. If you want only one delegate type, or three, or ten, the system is flexible enough to handle it. However, it's recommended to K.I.S.S.

0.5 All UEffects

Table 5: All UBuffComponents currently implemented and tested.

Buff	Short Description	Implemented via	Priority	Note
Dimensional Shift	See Invulnerable.	See Invulnerable.	See Invulnerable.	Inherits directly from UInvulnerable. It's only around as a Sprit-flavored invulnerability.
Invulnerable	No damage for 1 second	BeforeModifyStat	100	A lot of things can inherit from this, such as UDimensionalShift.

Table 6: All UDebuffComponents currently implemented and tested.

Debuff	Short Description	Implemented via	Priority	Note
Broken Soul	-50% healing for 5 seconds.	BeforeModifyStat	80	−−

Table 7: All UDoTComponents currently implemented and tested.

DoT	Short Description	Implemented via	Priority	Note
Cytotoxin	−1% HP every 1 sec for 3 seconds. 3 stacks max.	TickComponent	50	It's a medium amount, but scales well.

Table 8: All UHoTComponents currently implemented and tested.

HoT	Short Description	Implemented via	Priority	Note
Regrowth	+1% HP every 1 sec for 5 seconds. 3 stacks max.	TickComponent	50	It's a medium amount, but scales well.

Table 9: All UMutationComponents currently implemented and tested.

Mutation	Short Description	Implemented via	Priority	Note
Berserker Gene	+15% PhA −10% PhD −10% SpD	AfterRecalculateStats	50	It's a little unimaginitive, but that's okay.

Table 10: All UNegativeAuraComponents currently implemented and tested.

NegativeAura	Short Description	Implemented via	Priority	Note
Wounded Soul	−25% healing.	BeforeModifyStat	50	−−

Table 11: All UPositiveAuraComponents currently implemented and tested.

PositiveAura	Short Description	Implemented via	Priority	Note
Full Bloom	+20% max HP.	PermStatMod	50	−−

0.6 Dependent Effects

UDependentEffectComponents add common, cross-class functionality to other effects. Any UDependentEffectComponent:

- has an Owner that it's dependent upon.
- is automatically added just after its Owner is added.
- is automatically destroyed just before its Owner is destroyed. This also happens if the dependent is unregistered.
- follows its Owner's Silence and Unsilence.
- returns its Owner's Priority, Stacks, MaxStats, Priority, and ShouldApplyEffect.
- is not visible to UI.

0.6.1 Concrete Example

For example, both UBerserkerGene (a UMutation) and UFullBloom (a UPositiveAura) modify stats. Despite being different inheritance hierarchically, they do pretty similar things. They utilize UPermStatMod. For this example,

- The UEffectComponent is UBerserkerGene
  ↳ +15%PhA | -10% PhD | -10%SpD
- The UDependentEffectComponent is UPermStatMod

To attach UPermStatMod to UBerserkerGene, add the following to UBerserkerGene::OnComponentCreated:

```
void UBerserkerGene::OnComponentCreated()
{

    Super::OnComponentCreated();
    ADD_COMPONENT(UPermStatMod, PermStatMod, GetOwner())
    PermStatMod->StatMods = {
        {EStatEnum::PhysicalAttack, Modification: 15, EModificationMode::AddPercentage, EStatValueType::Permanent},
        {EStatEnum::PhysicalDefense, Modification: -10, EModificationMode::AddPercentage, EStatValueType::Permanent},
        {EStatEnum::SpecialDefense, Modification: -10, EModificationMode::AddPercentage, EStatValueType::Permanent},
    };
    PermStatMod->SetOwner(this); // Also applies it
}
```

You can also initialize things on the UPermStatMod side of things. For example, if you wanted to make sure there were stats attached to the new owner:

```
void UPermStatMod::SetOwner(UEffectComponent* NewOwner)
{

    // Careful! Squirrels everywhere...
    if (NewOwner != nullptr)
    {

        // Get StatsComponent
        SEARCH_FOR_COMPONENT_OR_DESTROY(UCombatStatsComponent, StatsComponent, NewOwner->GetOwner(), true)

        // No stats component?
        if (StatsComponent == nullptr)
        {
            UE_LOG(LogTemp, Warning, TEXT("No UCombatStatsComponent found for PermStatMod!"
                                "This is required *before* the Owner is set."))
            return;
        }
    }
```

0.6.2 List of UDependentEffectComponents

Table 12: All UDependentComponents currently implemented and tested.

Dependent	Short Description	Implemented via	Priority	Note
PermStatMod	Modifies EStatEnums according to its TArray of FStatMods.	AfterRecalculateStats	*Dependent*	See, e.g., UBerserkerGene.